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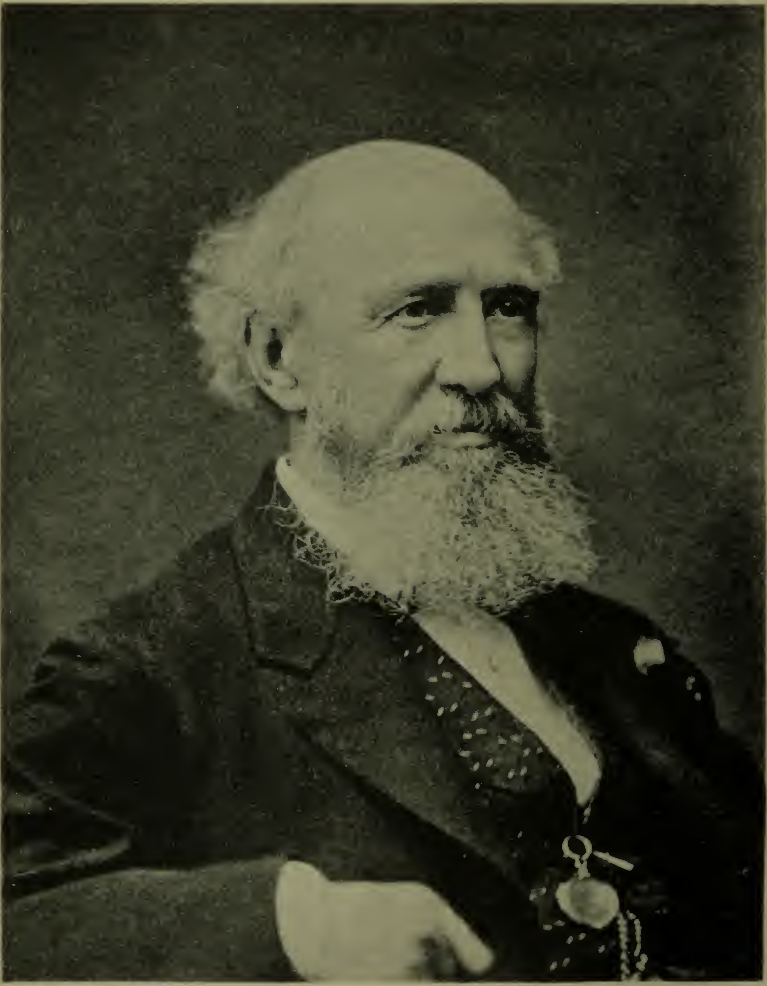

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PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

VOLUME XVIII.–1891-92.

EDITED BY

THOMAS COLE,

ASSOC. M. INST. C.E.

(*Secretary of the Association*).

The Association is not as a body responsible for the facts and opinions advanced herein.

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2. James Lemon, M. Inst. C.E., *Past President.*
3. Frederick Ashmead, M. Inst. C.E., *Past President.*
4. T. De Courcy Meade, M. Inst. C.E., *Past President.*

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Hepworth, J. M. Inst. C.E.	Engineer to the Gas and Waterworks of the Corporation of Carlisle.
Herbert, E. J. W.	Late Surveyor to the Local Board, Hanwell, W.
Heron, J., B.E., B.A.	County Surveyor, Monaghan, Ireland.
Heward, T. L.	Surveyor to the Local Board, Carshalton.
Hewson, T., M. Inst. C.E. (*Vice-President.*)	Borough Engineer, Leeds.
Hickes, T. J.	County Surveyor, Cornwall (Western division), Truro.
Higginson, T.	28, Deacon Road, Appleton, Widnes.
Hikeley, G. S.	Surveyor to the Local Board, Saltburn-by-the-Sea.

Hill, J., M. Inst. C.E.	County Surveyor, Clare, Ireland. Ennis.
Hiscocks, A. M., Assoc. M. Inst. C.E.	Surveyor to the Parish of St. George the Martyr, Southwark.
Hodge, J. L., A.M.I.C.E.	Surveyor to the Local Board, East Stonehouse, Devon.
Hodson, Geo., M. Inst. C.E.	Loughborough. Abbey Buildings, Prince's Street, Westminster, S.W.
Holden, Jas., A.M.I.C.E.	Surveyor to the Highway Board, Llandaff.
Hollings, G.	Surveyor to the Local Board, Wallsend.
Holmes, G. W., A.M.I.C.E.	Surveyor to the Local Board, Walthamstow.
Holt, A., Assoc. M. Inst. C.E.	Borough Surveyor, Lewes, Sussex.
Holt, G. F.	Surveyor, Poplar.
Hooley, Cosmo C., Assoc. M. Inst. C.E.	Rural Sanitary Authority, Barton-upon-Irwell, Patricroft.
Hooley, E. P., A.M. Inst. C.E.	County Surveyor, Nottingham.
Hooper, J. D.	Surveyor to the Local Board, Woodford, Essex.
Hope, W. H.	Surveyor to the Rural Sanitary Authority, Kingston-on-Thames.
Hopkinson, W. H.	Borough Engineer, Keighley.
Horan, J. M.E., M.I.C.E.	County Surveyor, Limerick, Ireland.
Horton, G. S.	Surveyor to the Local Board, Felixstowe.
Howcroft, James (*Member of Council.*)	Surveyor, Kirkleatham Local Board, Redcar, Yorkshire; *Hon. Sec.*, Northern Counties District.
Hughes, Robt.	Town Surveyor, Rhyl, Flintshire.
Humphries, T.	Town Surveyor, Mexborough.
Hutchinson, R.	Borough Surveyor, Huntingdon.

Inglis, J. C., M. Inst. C.E.	Surveyor to the Local Board, Compton Gifford, Devon.
Iron, W.	Surveyor to the Vestry, Clerkenwell.
Irving, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.

Jackson, N.	County Surveyor, Co. Cork (West Riding), Bandon, Co. Cork.
Jameson, M. W.	Surveyor to the Local Board, South Hornsey.
Jeeves, Ed.	Surveyor to the Local Board, Melton Mowbray.
Jevons, J. H.	Surveyor to the Local Board, Braintree.
Jennings, G.	Borough Surveyor, Rotherham.
Jones, A. S., Lt.-Col., V.C., Assoc. M. Inst. C.E.	Engineer to Urban Sanitary Authority, Wrexham. "Culverside," Carshalton, Surrey.
JONES, C., M. Inst. C.E. (*Past President and General Hon. Secretary.*)	Surveyor to the Local Board, Ealing, Middlesex.
Jones, I. M., Assoc. M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
Jones, W., A.M.I.C.E.	Surveyor to the Local Board, Colwyn Bay.
Jukes, W. H.	Surveyor to the Local Board, Tipton.

Kemp, J.	Surveyor to the Local Board, Hampton, Middlesex.
Kennedy, J. D.	Town Surveyor, Retford.
Kidd T.	City Engineer, Ripon.
Kilford, H. J.	Borough Surveyor, Ilkeston, Derbyshire.
Kirk, Thos., A. M. Inst. C.E.	Brisbane, Queensland.
Kirkby, S. A.	County Surveyor, Cork, (South division), E. Riding.

Lacey, F. W., As. M. In. C.E.	Town Surveyor, Bournemouth.
Laffan, G. B., A.M.I.C.E.	Engineer to the Local Board, Twickenham.
Landless, J. T.	Surveyor to the Local Board, Brierfield, Lancs.
Latham, E. D., A.M.I.C.E.	Borough Surveyor, Middlesbrough, Yorkshire.

Law, E.	County Surveyor, Northampton.
Law-Green, C., Assoc. M. Inst. C.E.	Waterworks, Oundle, Northamptonshire.
LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
Lawson, C. G., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Southgate.
Leete, Wm. H., A.M.I.C.E.	County Surveyor, Bedford.
LEMON, J., M. Inst. C.E. (*Past President.*)	Consulting Engineer, Southampton; and 9, Victoria Street, Westminster.
Lewis, T. L.	Town Surveyor, St. George, Bristol.
Lilley, G. H.	Surveyor to the Local Board, Ashby-de-la-Zouche.
Livesay, J. G., A.M.I.C.E.	Consulting Engineer to the Local Board, Ventnor.
Livingstone, Geo.	Surveyor to the Vestry, St. George, Hanover Square.
LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
Lockwood, P. C., M.I.C.E.	Late Borough Surveyor, Brighton, Sussex.
Lomax, C. Jas., A.M.I.C.E.	Engineer to the Failsworth Local Board, Lancashire.
Lovegrove, E. J., A.M.I.C.E.	Borough Engineer, Richmond, Surrey.
Lowe, C. H., A.I.C.E. (*Member of Council.*)	Surveyor to the Vestry, Hampstead.
Lund, J.	Borough Surveyor, Bedford.
Lynam, P. J.	County Surveyor, Louth. Dundalk, Ireland.
Lyons, A. O., M.I.C.E.	County Surveyor, Co. Cork (East).
MacBrair, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
Macdonald, D. G., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Gainsborough.
Mair, H., Assoc. M. Inst. C.E.	Surveyor to the Parish of Hammersmith.
Mallinson, J.	Surveyor to the Local Board, Colne, Lancashire.
Mallinson, T.	Surveyor to the Local Board, Selby.
Maltby, F. T., A.M.I.C.E.	Borough Surveyor, Guildford.
Mann, Jabez, A.M.I.C.E.	Surveyor to the Local Board, Sevenoaks.
Manning, G. W.	Surveyor to the Local Board, Biggleswade, Beds.
Marks, H. C., A.M.I.C.E.	Borough Engineer, Dewsbury.
Marks, T. T., A.M.I.C.E.	Late Town Surveyor, Llandudno, Carnarvonshire.
Marsh, R. S.	Surveyor to the Local Board, Cockermouth.
Marshall, P. P.	Late Borough Engineer, Norwich.
Marston, C. F., Assoc. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
Mason, C., Assoc. M. Inst. C.E.	Surveyor to the Vestry, St. Martin-in-the-Fields, Town Hall, Charing Cross, S.W.
Mason, W. A.	Surveyor to the Local Board, Shildon, near Darlington.
Massie, F., Assoc. M. Inst. C.E.	Surveyor to the Rural Sanitary Authority, Wakefield.
Mathews, G. S.	Surveyor to the Local Board, Dorking.
Mawbey, E. G., Assoc. M. Inst. C.E.	Borough Engineer, Leicester.
Mawson, R. C.	Borough Surveyor, Evesham.
Mawson, Jno.	Late Local Board, Shaw, near Oldham.
May, F. J. C., Assoc. M. Inst. C.E.	Borough Engineer and Surveyor, Brighton.
Mayne, C.	Engineer and Surveyor, Municipal Council, Shanghai.
McBeath, A. G., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Sale, Cheshire.
McCallum, J. B., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Blackburn.

McKelvie, W., A.M.I.C.E.	City Surveyor, Ely.
McKie, H. U., M. Inst. C.E.	11, Victoria Street, Westminster, S.W.
Meaby, M. C.	Surveyor to the Vestry, St. Luke, Middlesex.
Meade, T. De Courcy, M.I.C.E. (*Past President.*)	Surveyor to the Local Board, Hornsey.
Metcalf, J. W., A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Ashby-de-la-Zouche.
Middlebrook, S.	Surveyor to the Local Board, Walton-on-the-Hill.
Middleton, R. H., A.M.I.C.E.	Borough Surveyor, Walsall.
Mitchell, J.	Borough Surveyor, Hyde, Manchester.
Molineux, W. F. T	Town Surveyor, Shifnal, Salop.
Moore, G. J.	County Surveyor, Wisbech.
Moore, J. H.	County Surveyor, Co. Meath. 63, Eccles Street, Dublin.
Morgan, J.	Surveyor to the Pontardawe Rural Sanitary Authority, Swansea.
Morgan, W. B., A.M.I.C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
Mortimer, J.	Surveyor to the Local Board, Tettenhall, near Wolverhampton.
Mountain, A. H.	Surveyor to the Local Board, Withington, near Manchester.
Moynan, J. O.	County Surveyor, Co. Tipperary (North).
Murch, P.	Borough Engineer, Portsmouth.
Myatt, J.	Town Surveyor, Leek.
Newman, F.	Borough Engineer, Ryde, Isle of Wight.
Newton, G. H.	Surveyor to the Local Board, Denton, Manchester.
Newton, J., M. Inst. C.E.	Carlton Buildings, Manchester; Engineer to the Local Board, Bowdon, Cheshire.
Newton, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
Norrington, J. P., Assoc.M. Inst.C.E.	Surveyor to the Vestry, Fulham.
Norrish, G. R.	Surveyor to St. Saviour, Southwark.
Nuttall, T., Assoc. M. Inst. C.E.	Surveyor to the Local Boards, Kearsley and Ramsbottom, Lancashire. 12, Market Street, Bury, Lancs.
Orchard, W. P., B.E.	County Surveyor, North Mayo, Ireland.
Ottley, D. G.	County Surveyor, Co. Leitrim.
Oxtoby, W.	Borough Surveyor, Beverley.
Palmer, P. H., A.M.I.C.E.	Borough Engineer, Hastings.
Parker, J., Assoc. M. Inst. C.E.	Surveyor to the Basford Union Rural Sanitary Authority, Nottingham.
Parker, J., A.M.I.C.E.	City Surveyor, Hereford.
Parkinson, Jas., A.M.I.C.E.	Surveyor to the Local Board, Turton, near Bolton.
Parry, A. W., Assoc. M. Inst. C.E.	Late Borough Surveyor, Reading. 17, Market Place, Reading.
Pattison, J., jun.	Borough Surveyor, Newcastle-under-Lyme.
Peirce, R., A.M.I.C.E.	Municipal Engineer, Penang Straits Settlements
Penty, W. G.	Surveyor to the Rural Sanitary Authority, York.
Perry, J.	County Surveyor, Co. Galway (West Riding).
Petch, J.	Borough Surveyor, Scarborough.
Petree, J.	Borough Surveyor, Jarrow.
Phillips, R.	County Surveyor, Gloucester.
Pickering, Richard	11, Lowther Street, Whitehaven.
Pickering, J. S.	Surveyor to the Local Board, Nuneaton.
Pilditch, J. T.	Surveyor to the Parish of Battersea.
Platt, S. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale; *Hon. Secretary*, Lancashire and Cheshire District.
Pollard, J., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Hendon. 7, Gt. Queen Street, Westminster.

Porter, R.	Borough Surveyor, Wakefield.
Powell, D. H. W.	Town Surveyor, Pontypool.
Pratt, R.	Borough Surveyor, Henley-on-Thames.
Press, W. J.	Surveyor to the Local Board, Burnham, Somerset.
Price, John, Assoc. M. Inst. C.E.	Surveyor to the Local Board, Toxteth Park, Liverpool.
PRITCHARD, EDWARD, M. Inst. C.E. (*Past President.*)	37, Waterloo Street, Birmingham; and 1, Victoria Street, Westminster, S.W.
Proctor, J., M. Inst. C.E.	13, Mawdesley Street, Bolton, Lancashire.
Prouse, O. M., A.M.I.C.E.	Surveyor to the Local Board, Ilfracombe.
Purnell, E. J.	City Surveyor, Coventry, Warwickshire.

Radford, J. C., Assoc. M. Inst. C.E.	District Surveyor, Putney.
Rapley, Wm., jun.	Surveyor to the Dorking Rural Sanitary Authority.
Read, Richard, Assoc. M. Inst. C.E.	City Surveyor, Gloucester.
Reynolds, E. J.	Surveyor to the Local Board, Friern Barnet.
Richards, Hy.	Surveyor to the District Highway Board, Mortlake.
Richards, R. W., A.M.I.C.E.	City Surveyor, Sydney, N.S.W.
Richardson, H., A.M.I.C.E.	Surveyor to the Local Board, Oldbury.
Richardson, Jas.	Urban Sanitary Authority, Stamford.
Ridout, A. R.	Surveyor to the Local Board, Wirksworth, Derbyshire.
Roberts, R. O. W.	Borough Engineer, Carnarvon.
Robinson, W. P.	Surveyor to the Local Board, Skelton-in-Cleveland.
Robinson, W. J., Assoc. M. Inst. C.E.	City Surveyor, Londonderry.
Robinson, Jas., A.M.I C.E.	County Surveyor, Hants, Winchester.
Robson, O. C., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Local Board Willesden, Middlesex; *Hon. Secretary*, Home Counties District.
Ross, P., A.M.I.C.E.	Surveyor to the Local Board, North Bierley, Bradford.
Rothera, F.	Surveyor to the Local Board, Sowerby Bridge.
Rothwell, E.	Tramways Co., Rochdale.
Rounthwaite, R. S.	Borough Engineer, Sunderland.
Royle, H., A.M.I.C.E.	Surveyor to the Local Board, Stretford, Lancashire.
Ruck, F. W.	County Surveyor, Kent. Maidstone.
Rush, J.	Borough Surveyor, Eye, Suffolk.

Sadler, G. W.	Late Surveyor to the Sanitary Authority, Cheltenham.
Saise, A. J.	Surveyor to the Local Board, Stapleton, Bristol.
Salmon, A., A.M.I.C.E.	Surveyor to the Local Board, Wallasey, Cheshire.
Sanders, R. B.	County Surveyor, King's County.
Sasse, G. H.	Borough Surveyor, Chelmsford.
Savage, Wm. Hy.	Surveyor to the Local Board, East Ham.
Scoones, W. G.	Borough Surveyor, Maidstone.
Scott, A. F.	Surveyor to the Local Board, Cromer.
Scott, H. H., A.M.I.C.E.	Engineer to the Commissioners, Hove.
Scott, R. S.	Surveyor to the Local Board, Bishop's Stortford.
Shackleton, C. W.	Surveyor to the Local Board, Coseley.
Sharman, E.	Surveyor to the Local Board, Wellingborough, Northamptonshire.
Shaw, J.	Surveyor to the Local Board, Swinton, Manchester.
Shaw, J. H.	Surveyor to the Local Board, Brownhills, Staffordshire.
Shaw, H., A.M.I.C.E.	Surveyor to the Local Board, Todmorden.

Sheard, W. C.	Surveyor to the Local Board, Heaton Norris, Stockport.
Shepherd, G. J.	Highway Surveyor, Kidderminster.
Shillington, H.	Town Surveyor, Lurgan, Ireland.
Siddons, J. M.	Town Surveyor, Oundle.
Silcock, E. J., A.M.I.C.E.	Borough Surveyor, King's Lynn.
Simpson, J.	Wirksworth, Derbyshire.
Simpson, W. H., A.M.I.C.E.	Surveyor to the Blaby Union R.S.A., Leicester.
Sinclair, J. S.	Surveyor to the Local Board, Widnes.
Smith, C. C.	Surveyor to the Local Board, Dalton-in-Furness.
Smith, J.	County Surveyor, Co. Galway (E. Riding).
Smith, I. C.	Surveyor to the Rural Sanitary Authority, Chelmsford.
Smith, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District.
Smith, T. R., A.M.I.C.E.	Surveyor to the Local Board, Kettering.
Smith, W. Howard, Assoc. M.Inst. C.E.	City Engineer, Carlisle.
Smythe, F.	Local Board, Finchley, N.
Somerville, R, N., B.E.	County Surveyor, Cavan, Ireland.
Southam, A., A.M.I.C.E.	Surveyor, Clapham, London, S.W.
Spencer, J. P., A. M. Inst. C.E.	32, Moseley Street, Newcastle-on-Tyne.
Spinks, W., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Dukinfield. 9, Albert Square, Manchester.
St. George, Percival, M.Inst. C.E.	City Engineer, Montreal, Canada.
Stainthorpe, T. W.	Surveyor to the Eston District Local Board, Yorkshire.
Stallard, S.	Surveyor to the Rural Sanitary Authority, Maidstone.
Stead, S.	Borough Surveyor, Harrogate.
Stephenson, E. P., Assoc.M. Inst. C.E.	Town Surveyor, Llandudno.
Stevens, George	Local Board, Blaina, Mon.
Stevens, L.	Surveyor to the Local Board, Newton Abbott, Devon.
Stevenson, A.	District Surveyor, Ayrshire County Council.
Stevenson, J.	Surveyor to the Local Board, East Molesey.
Stewart, A.	Surveyor to the Rural Sanitary Authority, Maldon, Essex.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Newbury.
Stokoe, J.	Surveyor to the Local Board, Altrincham.
Strachan, G. R., Assoc. M. Inst. C.E.	Late Surveyor, Chelsea. Clovelly, Byne Road, Balham, S.W.
Strachan, J. H.	Surveyor to the Local Board, Brentford.
Stringfellow, H. W.	City Surveyor, Chichester.
Stuart, J. C.	Surveyor to the Local Board, Smethwick.
Stubbs, Wm., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
Sumner, F.	Surveyor to the Vestry, Bermondsey.
Swarbrick, Joseph, Assoc.M. Inst. C.E.	44, Brasenose Street, Albert Square, Manchester.
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Sykes, Ed., A.M.I.C.E.	Surveyor to the Local Board, Cheadle, Manchester.
Tanner, W.	County Surveyor, Monmouthshire. Newport.
Taylor, H. W.	Surveyor to the Local Board, Newmarket.
Taylor, T. G.	Town Surveyor, Douglas, Isle of Man.
Terrill, W.	Surveyor to the Local Board, Ashford, Kent.

Thomas, John, A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Swansea
Thomas, R. J., A.M.I.C.E.	County Surveyor, Bucks, Aylesbury.
Thomas, T. J., Assoc. M.Inst. C.E.	Surveyor to the Local Board, Ebbw Vale.
Thomas, W.	Surveyor to the Margam Local Board, Port Talbot, S. Wales.
Thomas, W., Assoc. M. Inst. C.E.	Borough Surveyor, Dover.
Thomas, W. E. C., Assoc. M. Inst. C.E.	Surveyor to the Rural Sanitary Authority, Neath.
Thompson, R.	Late Surveyor to the Local Board, Waterloo, near Liverpool.
Thorburn, T. C.	Borough Surveyor, Birkenhead.
Thorpe, Jas.	Surveyor to the Rural Sanitary Authority, Macclesfield.
Thorrold, S. E., A.M.I.C.E.	Barton House, South Stockton-on-Tees.
TILL, W. S., M. Inst. C.E. (*Past President.*)	Borough Engineer, Birmingham.
Towlson, S.	Surveyor to the Local Board, Erith.
Turnbull, A. J.	Borough Engineer, Greenock.

Vallance, R. F.	Town Surveyor, Mansfield.
Valon, W. A. McIntosh, Assoc. M.Inst.C.E.	Ramsgate Corporation Gas Works Engineer; and 140 and 141, Temple Chambers, Temple Avenue, E.C.
Veevers, H., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Dukinfield.
Ventris, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. 5, Tavistock Street, Covent Garden.

Wakelam, H. T., A.M.I.C.E.	County Surveyor, Hereford.
Walker, T., M. Inst. C.E. (*Member of Council*)	Borough Surveyor, Croydon, Surrey.
Wallace, G.	Surveyor to St. Giles District Board of Works.
Wallis, T. W.	Borough Surveyor, Louth, Lincoln.
Walshaw, J. W.	Borough Surveyor, Peterborough.
Wardle, J. W., Assoc. M. Inst. C.E.	Borough Surveyor, Longton.
Waterhouse, D.	Surveyor to the Local Board, Watford
Watkeys, G., A.M.I.C.E.	Surveyor to the Local Board, Llanelly.
Watson, J. D., Assoc. M. Inst. C.E.	County Sanitary Engineer, Aberdeenshire.
Watts, E. T.	Surveyor to the Rural Sanitary Authority, Bishop's Stortford.
Waye, H.	Surveyor to the Local Board, Millom, Cumberland.
Weaver, Wm., M. Inst. C.E.	Surveyor to the Vestry, Kensington.
Webster, J. L.	Surveyor to the Local Board, Portland.
Welburn, W.	Borough Surveyor, Middleton, near Manchester.
Weston, Geo.	Surveyor to the Vestry, Paddington.
Weston, H. J., Assoc. M. Inst. C.E.	Surveyor to the Local Board, Shirley and Freemantle, Southampton.
Wheeler, G. R. W., Assoc. M. Inst. C.E.	Surveyor to the Vestry, Westminster.
Whitbread, R.	Surveyor to the Local Board, Carlton, Notts.
White, A. E., Assoc. M.Inst. C.E	Borough Engineer, Hull.
White, H. V.	County Surveyor, Queen's County, Portarlington.
WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
Whitmore, F.	County Surveyor, Essex, Chelmsford.
Widdowson, W. C.	Surveyor to the Local Board, Tredegar, Mon.

Wike, C. F., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Sheffield.
Wild, G. H.	Surveyor to Local Board, Littleborough, near Manchester.
Wilkinson, J. P., Assoc. M. Inst. C.E.	Assheton Road, Clayton Bridge, Manchester.
Willcox, J. E., Assoc. M. Inst. C.E.	118, Colmore Row, Birmingham.
Willmot, J.	County Surveyor, Warwickshire. 6, Waterloo St., Birmingham.
Willson, F. R. T.	County Surveyor, Co. Fermanagh, Enniskillen.
Wilson, C. L. N.	Town Surveyor, Bilston.
Wilson, Geoffrey	Surveyor to the Local Board, Alnwick.
Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Wilson, J. B.	Surveyor to the Rural Sanitary Authority, Cockermouth.
Window, E. R., Assoc. M. Inst. C.E.	Late Surveyor to the Local Board, Bishop's Stortford. 16, Cook Street, Liverpool.
Winship, G., A. M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
Wood, A. R.	Surveyor to the Local Board, Tunstall.
Woodbridge, C. A.	Surveyor to the Hendon Union Rural Sanitary Authority.
Worth, J. E., Assoc. M. Inst. C.E.	Engineer to the Local Board, Tottenham.
Wyatt, W. J.	Surveyor to the Local Board, Paignton, Devon.
Yates, F. S., A. M. Inst. C.E.	Surveyor to the Local Board, Waterloo, near Liverpool.
York, E. A.	95, Upper Walhouse Street, Walsall.

TOWNS AND DISTRICTS REPRESENTED BY MEMBERS OF THE ASSOCIATION.

Aberdeenshire	J. D. Watson.
Abergavenny	Jon. Haigh.
Abingdon	G. Winship.
Abram	Geo. Heaton.
Accrington	W. J. Newton.
Acton	D. J. Ebbetts.
Allerton	A. O. Fraser.
Alnwick	G. Wilson.
Altrincham	J. Stokoe.
Alverstoke	W. H. Fry.
Antrim (County)	J. H. Brett.
Armagh (County)	R. H. Dorman.
Ashby-de-la-Zouche	G. H. Lilley
„ „ (Rural)	J. W. Metcalf.
Ashby Woulds	C. T. Garratt.
Ashford	W. Terrill.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	Geo. Heaton.
Aston Manor	W. A. Davies.
Aston (Rural)	R. H. Hawgood.
Atherstone (Rural)	W. R. H. Chipperfield.
Audenshaw	J. H. Burton.
Aylesbury	G. Cannon.
Ayrshire (County)	A. Stevenson.

Bacup	J. Wilson.
Barking	C. J. Dawson.
Barton-upon-Irwell	C. C. Hooley.
Basford Union (Rural)	J. Parker.
Batley	Hy. Dearden.
Battersea	J. T. Pilditch.
Banbury	S. E. Burgess.
Bedford	J. Lund.
„ (County)	W. H. Leete.
Bedlington	C. A. Copland.
Beeston	G. W. Hawley.
Belfast	J. C. Bretland.
Bermondsey	F. Sumner.
Bethnal Green	F. W. Barratt.
Beverley	W. Oxtoby.
Biggleswade	G. W. Manning.
Billesden (R.S.A.)	W. F. Ault.
Bilston	C. L. N. Wilson.
Bingley	R. Armistead.
Birkenhead	T. C. Thorburn.
Birmingham	W. S. Till.
„	E. Pritchard.
Bishop's Stortford	R. S. Scott.
„ „ (Rural)	E. T. Watts.
Blaby (Rural)	W. H. Simpson.
Blackburn	J. B. McCallum.
Blaina	G. Stevens.
Bolton	W. H. Brockbank.
„	J. Proctor.

Bootle	J. A. Crowther.
Bournemouth	F. W. Lacey.
Bowdon	J. Newton.
Bradford	J. H. Cox.
Braintree	J. H. Jevons.
Bray	P. F. Comber.
Brecknock	R. Davies.
Brentford	J. H. Strachan.
Bridlington	R. R. Brown.
„	S. Dyer.
Brierfield	J. T. Landless.
Brierley Hill	J. W. Beckley.
Brighton	F. J. C. May.
„	P. C. Lockwood.
Brisbane, Queensland	T. Kirk.
Bristol	F. Ashmead.
„ (St. George)	T. L. Lewis.
Bromley	H. S. Cregeen.
Brownhills	J. H. Shaw.
Buckingham (County)	R. J. Thomas.
Burnham	W. J. Press.
Burnley	F. S. Button.
„ (Rural)	S. Edmundson.
Burslem	F. Bettany.
Burton-upon-Trent	J. E. Swindlehurst.
Bury	J. Cartwright.

Canterbury	F. Baker.
Cape Town, S.A.	T. W. Cairncross.
Cardiff (Rural)	W. Fraser.
Carlisle	W. H. Smith.
„	J. Hepworth
Carlton	R. Whitbread.
Carnarvon	R. O. W. Roberts.
Carshalton	T. L. Heward.
Cavan (County)	R. N. Somerville.
Cheadle	E. Sykes.
Chelmsford	G. H. Sasse.
„ (Rural)	I. C. Smith.
Cheltenham	Jos. Hall.
„	G. W. Sadler.
Cheshunt	T. Bennett.
Chester	I. M. Jones.
Chesterton	D. Bland.
Chichester	H. W. Stringfellow.
Clapham, S.W.	A. Southam.
Clare (County)	J. Hill
Cleator Moor	F. J. Edge.
Clerkenwell	W. Iron.
Cockermouth	R. S. Marsh.
„ (Rural)	J. B. Wilson.
Colchester	H. Goodyear.
Colne	J. Mallinson.
Colwyn Bay	W. Jones.
Compton Gifford	J. C. Inglis.
Congleton	R. Burslam.
Cork (County)	N. Jackson.
„ „	S. A. Kirkby.
„ „	A. O. Lyons.
Cornwall (County), W.	T. J. Hickes.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.

Crewe	G. Eaton-Shore.
Cromer	A. F. Scott.
Croydon	T. Walker.
,, (Rural)	R. M. Chart.
Dalton-in-Furness	C. C. Smith.
Darwen	W. Stubbs.
Denton	G. H. Newton.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
,, (Rural)	C. C. Barras.
Dorking	G. S. Mathews.
,, (Rural)	W. Rapley, jun.
Douglas	T. G. Taylor.
Dover	W. Thomas.
Down (County)	P. C. Cowan.
Droitwitch	B. Godfrey.
Dublin	C. Harty.
,, (County)	R. A. Gray.
,, ,, South Division	W. Collen
Dudley	J. Gammage.
Dukinfield	H. Veevers.
Durham (Rural)	G. Gregson.
Ealing	C. Jones.
East Ham	W. H. Savage.
East Molesey	J. Stevenson.
East Stonehouse	J. C. Hodge.
Ebbw Vale	T. J. Thomas.
Edinburgh	J. Cooper.
Edmonton	G. E. Eachus.
Ely	W. McKelvie.
Epsom	J. R. Harding.
Erith	S. Towlson.
Essex (County)	F. Whitmore.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.
Exmouth	W. H. Beswick.
Eye	J. Rush.
Failsworth	C. J. Lomax.
Fareham	W. Butler.
Felixtowe	G. S. Horton.
Fermanagh (County)	F. R. T. Willson.
Finchley	F. Smythe.
Fleetwood	M. S. Gaulter.
Friarn Barnet	E. J. Reynolds.
Frodsham	W. Diggle.
Frome	P. Edinger.
,, (Rural)	A. Greenwell.
Fulham	J. P. Norrington.
Gainsborough	D. G. Macdonald.
Galway (County)	J. Perry.
,, ,,	J. Smith.
Garston	H. T. Wakelam.
Gateshead-on-Tyne	J. Bower.
Gloucester	R. Read.
,, (County)	R. Phillips.
Grantham	J. Evans.
Great Crosby	W. Hall.
Great Yarmouth	J. W. Cockrill.

Greenock	A. J. Turnbull.
Guildford	F. T. Maltby.
Halifax	E. R. S. Escott.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Hampton	J. Kemp.
Hanley	J. Lobley.
Hants (County)	J. Robinson.
Hanwell	S. W. J. Barnes.
„	E. J. W. Herbert.
Harborne	R. Dixon.
Harrogate	S. Stead.
Harrow	E. R. Capon.
Hartlepool	H. C. Crummack.
Harwich	H. Ditcham.
Hastings	P. H. Palmer.
Heaton Norris	W. C. Sheard.
Heckmondwike	T. Gledhill.
Hendon	S. S. Grimley.
„ (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Hereford	J. Parker.
Hertford	T. R. Dickinson.
Heston and Isleworth	W. B. Bromley.
Hexham	R. Grieves.
Heywood	J .Diggle.
Hinckley	W. W. Cooper
Hornsea	P. Gaskell.
Hornsey	T. De C. Meade.
Houghton-le-Spring	T. Foster.
Hounslow	W. B. Bromley.
Hove	H. H. Scott.
Hull	A. E. White.
Huntingdon	R. Hutchinson.
Hyde	J. Mitchell.
Ilfracombe	O. M. Prouse.
Ilkeston	H. J. Kilford.
Ipswich	E. Buckham.
Isle of Ely (County)	G. J. Moore.
Jarrow	J. Petree.
Johannesburg, S.A.	G. R. Andrews.
Kearsley	T. Nuttall.
Keighley	W. H. Hopkinson.
Kensington	W. Weaver.
Kent (County)	F. W. Ruck.
Kettering	T. R. Smith.
Kidderminster	A. Comber.
„ (Highways)	G. J. Shepherd.
Kildare (County)	E. Glover.
Kilkenny (County)	P. Burtchaell.
King's County	R B. Sanders.
King's Lynn	E. J. Silcock.
King's Norton (Rural)	R. Godfrey.
Kingston (Highway Board)	A. J. Henderson.
„ (Rural)	W. H. Hope.
Kingstown	J. Berry.
Kirkleatham	J. Howcroft.

Lancaster	J. Cook.
Leamington Spa	W. De Normanville.
Leeds	T. Hewson.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
,,	F. Griffiths.
Leith	W. Beatson.
Leitrim (County)	D. G. Ottley.
Lewes	A. Holt.
Lewisham	J. Carline.
Leyton, E.	W. Dawson.
Lichfield	C. J. Corrie.
Limerick (County)	J. Horan.
Lincoln	R. A. MacBrair.
Littleborough	G. H. Wild.
Liverpool	H. P. Boulnois.
,,	G. Biddle.
Llandaff	Jas. Holden.
Llandudno	E. P. Stephenson.
,,	T. T. Marks.
Llanelly	G. Watkeys.
London (County)	A. R. Binnie.
Londonderry, Ireland	W. J. Robinson.
Longford (County)	J. W. Gunnis
Longton	J. W. Wardle.
Loughborough	Geo. Hodson.
Louth, Lincoln	T. W. Wallis.
Louth (County)	P. J. Lynam.
Lowestoft	G. H. Hamby.
Lurgan	H. Shillington.

Macclesfield (Rural)	J. Thorpe.
Maidstone	W. G. Scoones.
,, (Rural)	S. Stallard.
Maldon (Rural)	A. Stewart.
Manchester	J. Newton.
Mansfield	R. F. Vallance.
Margam	W. Thomas.
Market Harboro'	H. G. Coales.
Meath (County)	J. H. Moore
Melton Mowbray	E. Jeeves.
Mexborough	T. Humphries.
Middlesbrough	E. D. Latham.
Middleton, Lancashire	W. Welburn.
Millom	H. Waye.
Milton-next-Sittingbourne	A. B. Acworth.
Milverton	G. F. Smith.
Mirfield	F. H. Hare.
Monaghan (County)	J. Heron.
Monmouthshire (County)	W. Tanner.
Montreal, Canada	P. St. George.
Mortlake (Highway Board)	H. Richards.

Neath (Rural)	W. E. C. Thomas
Nelson-in-Marsden	W. Dent.
New Barnet	G. W. Brumell.
Newbury	E. A. Stickland.
Newcastle-on-Tyne	W. G. Laws.
,,	J. P. Spencer.
Newcastle-under-Lyme	J. Pattison, jun.
New Malden	T. L. Heward.
Newmarket	H. W. Taylor.

Newport, Salop	G. B. Hammonds.
Newton Abbott	L. Stevens.
Newton-in-Makerfield	R. Brierley.
Newtown	R. W. Davies.
Northampton (County)	E. Law.
North Bierley	P. Ross.
North Mayo (County)	W. P. Orchard.
Norwich	J. Buchan.
,,	P. P. Marshall.
Nottingham	A. Brown.
,, (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.

Okehampton	H. Geen.
Oldbury	H. Richardson.
Orrell	G. Heaton.
Oundle	J. M. Siddons.
Oxford	W. H. White.

Paddington	Geo. Weston.
Padiham	J. Gregson.
Paignton	W. J. Wyatt.
Peebles (County)	R. S. Anderson.
Pemberton	Geo. Heaton.
Penang, Straits Settlements	R. Peirce.
Penmaenmawr	J. S. Coverley.
Peterborough	J. W. Walshaw.
Plumstead	W. G. Forder.
Plymouth	G. D. Bellamy.
Pontardawe (Rural)	J. Morgan.
Pontypool	D. H. W. Powell.
Poole	J. Elford.
Poplar	G. F. Holt.
Portland	J. L. Webster.
Portsmouth	P. Murch.
Prescot	W. Goldsworth.
Putney	J. C. Radford.

Queen's County	H. V. White.

Ramsbottom	T. Nuttall.
Ramsgate	W. A. M. Valon.
Reading	A. E. Collins.
,,	A. W. Parry.
Retford	J. D. Kennedy.
Rhyl	Robt. Hughes.
Richmond	E. J. Lovegrove.
Ripon	T. Kidd.
,,	H. Dearden.
Rochdale	S. S. Platt.
Rochester	W. Banks.
Rotherham	G. Jennings.
Rowley Regis	W. H. Brettell.
Rugby	J. H. Brierley.
Ryde	F. Newman.

Sale	A. G. McBeath.
Saltburn-by-the-Sea	G. S. Hikeley.
Scarborough	J. Petch.
Selby	T. Mallinson.
Sevenoaks	J. Mann.

Shanghia, China	C. Mayne.
Sheffield	C. F. Wike.
„	R. Davidson.
Sherborne	T. Farrall.
Shifnal	W. F. T. Molineux.
Shirley and Freemantle	H. J. Weston.
Shildon	W. A. Mason.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Skelton-in-Cleveland	W. P. Robinson.
Sleaford	Jesse Clare.
Slough	J. Baker.
Smethwick	J. C. Stuart.
Solihull (Rural)	A. E. Currall.
Somerton	I. T. Hawkins.
Southampton	W. B. G. Bennett.
„	J. Lemon.
South Brisbane	T. C. Deverell.
Southend-on-Sea	P. Dodd.
Southgate	C. G. Lawson.
South Hornsey	M. W. Jameson.
Southport	W. Crabtree.
South Shields	M. Hall.
Sowerby Bridge	F. Rothera.
Stafford	W. Blackshaw.
Stamford	Jas. Richardson.
Stapleton	A. J. Saise.
Stockport	J. Atkinson.
„	A. M. Fowler.
Stockton	K. F. Campbell.
Stourbridge	W. Fiddian.
Strand	A. Ventris.
Stratford-on-Avon	A. H. Campbell.
„	T. T. Allen.
Streatham	Jas. Barber.
Stretford	H. Royle.
St. George the Martyr, Southwark	A. M. Hiscocks.
St. George, Bristol	T. L. Lewis.
St. George's, Hanover Square	G. Livingstone.
St. Giles	G. Wallace.
St. Helen's	G. J. C. Broom.
St. Luke, Middlesex	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrish.
Suffolk (County)	J. Rush.
Sunderland	R. S. Rounthwaite.
Sussex (E.) (County)	Hy. Card.
Sussex (W.) (County)	C. Adcock.
Sutton Coldfield	C. F. Marston.
Sutton, Surrey	E. W. Crickmay.
Sutton-in-Ashfield	McW. Bishop.
Swansea	G. Bell.
„ (Rural)	J. Thomas.
Swinton	J. Shaw.
Sydney, N.S.W.	R. W. Richards.
Tamworth (Rural)	H. J. Clarson.
Tettenhall	J. Mortimer.
„	E. A. Yorke.
Tewkesbury, Gloucestershire	W. H. Gray.

Tipperary (County)	E. A. Hackett.
" "	J. O. Moynan.
Tipton	W. H. Jukes.
Todmorden	H. Shaw.
"	A. Greenwood.
Tooting	Jas. Barber.
Toowong, Queensland	W. E. Irving.
Torquay	H. A. Garrett.
Tottenham	J. E Worth.
Toxteth Park	J. Price.
Tredegar	W. C. Widdowson.
Tunstall	A. R. Wood.
Turton	Jas. Parkinson.
Twickenham	G. B. Laffan.
Ventnor	E. J. Harvey.
"	J. G. Livesay.
Wakefield	R. Porter.
" (Rural)	F. Massie.
Wallasey	A. Salmon.
Walsall	R. H. Middleton.
Wallsend	G. Hollings.
Walthamstow	G. W. Holmes.
Walton-on-the-Hill	S. Middlebrook.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Warwickshire (County)	J. Willmot.
Waterford (County)	W. E. L. Duffin.
Waterloo, Liverpool	F. S. Yates.
Watford	D. Waterhouse.
" (Rural)	G. A. Heath.
Wavertree	I. Dixon.
Wellingborough	E. Sharman.
West Bromwich	J. T. Eayrs.
West Cowes	N. F. Dennis.
West Ham, London	L. Angell.
West Hartlepool	J. W. Brown.
Westminster	G. R. W. Wheeler.
Weymouth and Melcombe Regis ..	W. B. Morgan.
Whitehaven	J. S. Brodie.
"	R. Pickering.
Widnes	J. S. Sinclair.
"	T. Higginson
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Wirksworth	A. R. Ridout
"	J. Simpson.
Withington	A. H. Mountain.
Wolverhampton	R. E. W. Berrington.
Woodford	J. D. Hooper.
Wood Green	C. J. Gunyon.
"	O. E. Harrison
Worksop	W. T. Brown.
" (Rural)	C. L. Walker.
Worthing	M. Aspinall.
Wrexham	J. W. M. Smith.
"	A. S. Jones.
" (Rural)	A. C. Baugh
York	A. Creer.
" (Rural)	W. G. Penty.

DISTRICTS.

No. 1.—THE HOME DISTRICT.

Hon. Secretary—O. C. Robson, Public Offices, Kilburn, N.W.

MEMBERS.

Acworth, A. B.	Town Surveyor, Milton-next-Sittingbourne, Kent.
Adcock, C.	County Surveyor, Sussex (West).
ANGELL, LEWIS, M.I.C.E. *(Past President and Treasurer.)*	Borough Engineer, West Ham.
Aspinall, M.	Borough Engineer, Worthing.
Baker, F.	City Surveyor, Canterbury.
Baker, J.	Town Surveyor, Slough.
Banks, W.	City Surveyor, Rochester.
Barber, Jas.	Surveyor to the Parishes of Streatham and Tooting. Endlesham Road, Balham, S.W.
Barber, J. P.	Surveyor to the Vestry, St. Mary, Islington.
Barnes, S. W. J.	Surveyor to the Local Board, Hanwell.
Barratt, F. W.	Surveyor to the Vestry, Bethnal Green.
Bennett, T., A.M.I.C.E.	Surveyor to the Local Board, Cheshunt.
Bennett, W. B. G., Assoc. M.I.C.E.	Borough Surveyor, Southampton.
Binnie, A. R., M. Inst. C.E. *(Vice-President.)*	Chief Engineer, London County Council, Spring Gardens, S.W.
Blair, W. N.	Surveyor to the Vestry, St. Pancras.
Bressey, J. T.	Surveyor to the Local Board, Wanstead, Essex.
Bromley, W. B., A.M.I.C.E.	Town Hall, Hounslow.
Brooke, W., A.M.I.C.E.	39, Victoria Street, S.W.
Brumell, G. W.	Surveyor to the Local Board, New Barnet.
Burgess, S. E.	Borough Engineer, Banbury.
Butler, W.	Surveyor to the Local Board, Fareham.
Cannon, G.	Surveyor to the Local Board, Aylesbury.
Capon, E. R.	Surveyor to the Local Board, Harrow.
Card, H.	County Surveyor, Lewes.
Carline, J., A.M.I.C.E.	District Surveyor, Lewisham. Catford Hill, S.E.
Chart, R. M.	Surveyor to the Rural Sanitary Authority, Croydon. Vestry Hall, Mitcham.
Collins, A. E., A.M.I.C.E.	Borough Surveyor, Reading.
Cooper, C. H., A.M I.C.E.	Surveyor to the Local Board, Wimbledon.
Cousins, E., M.I.C.E.	Late Borough Surveyor, Swansea. 9, Bridge Street, Westminster.
Cregeen, H. S.	Surveyor to the Local Board, Bromley, Kent.
Crickmay, E. W.	Surveyor to the Local Board, Sutton, Surrey.
Crimp, W. Santo, M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
Dawson, C. J.	Surveyor to the Local Board, Barking.
Dawson, W., A.M.I.C.E.	Surveyor to the Local Board, Leyton, E.
DEACON, G. F., M.I.C.E. *(Past President)*	32, Victoria Street, Westminster, S.W.

Dennis, N. F.	Town Surveyor, West Cowes.
Dickinson, T. R., A.M.I.C.E.	Borough Surveyor, Hertford.
Ditcham, H.	Borough Surveyor, Harwich.
Dodd, P., A.M.I.C.E.	Town Surveyor, Southend-on-sea.
Dunscombe, C., M. A., M.Inst. C.E.	20, Victoria Street, Westminster.
Eachus, G. E., M.I.C.E.	Surveyor to the Local Board, Edmonton.
Ebbetts, D. J.	Surveyor to the Local Board, Acton.
ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President*).	Late County Surveyor for Sussex (West). Connaught Mansions, Westminster, S.W.
Fairley, W., A.M.I.C.E.	Richmond Main Sewerage Board, Mortlake, S.W.
Forder, W. G., A.M.I.C.E.	Surveyor to the Plumstead District.
Fry, W. H., A.M.I.C.E.	Surveyor to the Local Board, Alverstoke.
Gamble, S. G., A.M.I.C.E.	Metropolitan Fire Brigade, Southwark Bridge Road.
Ginn, A. F.	Late Surveyor to the Rural Sanitary Authority, Chelmsford. Salisbury Villa, Quarry Road, Tunbridge.
Gledhill, J.	Late Surveyor to the Vestry, St. Mary, Newington.
Grimley, S. S., A.M.I.C.E.	Surveyor to the Local Board, Hendon.
Gunyon, C.J., A.M.I.C.E.	Surveyor to the Local Board, Wood Green.
Hanson, W.	Surveyor to the Highway Board, Wantage.
Harding, J. R., A.M.I.C.E.	Surveyor to the Local Board, Epsom, Surrey.
Harvey, E. J.	Surveyor to the Local Board, Ventnor.
Heath, G. A.	Surveyor to the Rural Sanitary Authority, Watford.
Henderson, A. J.	Surveyor to the District Highway Board, Kingston.
Herbert, E. J. W.	Late Surveyor to the Local Board, Hanwell, W.
Heward, T. L.	Surveyor to the Local Boards, New Malden and Carshalton.
Hiscocks, A. M., A.M.I.C.E.	Surveyor to the Parish of St. George the Martyr, Southwark.
Hodson, Geo, M.I.C.E.	Loughborough. Abbey Buildings, Prince's Street, Westminster, S.W.
Holmes, G. W.	Surveyor to the Local Board, Walthamstow.
Holt, A., A.M.I.C.E.	Borough Surveyor, Lewes, Sussex.
Holt, G. F.	Surveyor, Poplar.
Hooper, J. D.	Surveyor to the Local Board, Woodford, Essex.
Hope, W. H.	Surveyor to the Rural Sanitary Authority, Kingston-on-Thames.
Iron, W.	Surveyor to the Vestry, Clerkenwell.
Jameson, M. W.	Surveyor to the Local Board, South Hornsey.
Jones, A. C., Lt.-Col., Assoc. M.I.C.E.	"Culverside," Carshalton, Surrey.
JONES, C., M.I.C.E. (*Past President and General Hon. Secretary.*)	Surveyor to the Local Board, Ealing, Middlesex.
Kemp, J.	Surveyor to the Local Board, Hampton, Middlesex.
Lacey, F. W., A.M.I.C.E.	Town Surveyor, Bournemouth.
Laffan, G. B., A.M.I.C.E.	Engineer to the Local Board, Twickenham.
Lawson, C. G., A.M.I.C.E.	Surveyor to the Local Board, Southgate.
Leete, Wm. H., A.M.I.C.E.	County Surveyor, Bedford.
LEMON, J., M.I.C.E. (*Past President.*)	Consulting Engineer, Southampton; and 9, Victoria Street, Westminster.

Livesay, J. G., A.M.I.C.E.	Consulting Engineer to the Local Board, Ventnor.
Livingstone, Geo.	Surveyor to the Vestry, St. George, Hanover Sq.
Lockwood, P. C., M.I.C E.	Late Borough Surveyor, Brighton, Sussex.
Lovegrove, E. J.	Borough Engineer, Richmond, Surrey.
Lowe, C. H., A.I.C.E. *(Member of Council.)*	Surveyor to the Vestry, Hampstead.
Lund, J.	Borough Surveyor, Bedford.
Mair, H., A.M.I.C.E.	Surveyor to the Parish of Hammersmith.
Maltby, F. T., A.M.I.C.E.	Borough Surveyor, Guildford.
Mann, Jabez, A.M.I.C.E.	Surveyor to the Local Board, Sevenoaks.
Manning, G. W.	Surveyor to the Local Board, Biggleswade, Beds.
Mason, C., A.M.I.C.E.	Surveyor to the Vestry, St. Martin-in-the-Fields, S.W.
Mathews, G. S.	Surveyor to the Local Board, Dorking.
May, F. J. C., A.M.I.C.E.	Borough Engineer and Surveyor, Brighton.
McKie, H. U., M.I.C.E.	9, Bridge Street, Westminster.
Meaby, M. C.	Surveyor to the Vestry, St. Luke, Middlesex.
MEADE, T. DE COURCY, M.I.C E. *(Past President.)*	Surveyor to the Local Board, Hornsey.
Murch, P.	Borough Engineer, Portsmouth.
Newman, F.	Borough Engineer, Ryde, Isle of Wight.
Norrington, J. P., A.M.I.C.E.	Surveyor to the Vestry, Fulham.
Norrish, G. R.	Surveyor to St. Saviour, Southwark.
Palmer, P. H., A.M.I.C.E.	Borough Engineer, Hastings.
Parry, A. W., A.M.I.C.E.	Late Borough Surveyor, Reading. 22, The Forbury, Reading.
Pilditch, J. T.	Surveyor to the Parish of Battersea.
Pollard, J., A.M.I.C.E.	Late Surveyor to the Local Board, Hendon. 7, Great Queen Street, Westminster.
Pratt, R.	Borough Surveyor, Henley-on-Thames.
PRITCHARD, EDWARD, M.I.C.E. *(Past President.)*	37, Waterloo Street, Birmingham; and 2, Storey's Gate, S.W.
Radford, J. C., A.M.I.C.E.	District Surveyor, Putney.
Rapley, Wm., jun.	Surveyor to the Dorking Rural Sanitary Authority.
Reynolds, E. J.	Surveyor to the Local Board, Frian Barnet.
Richards, Hy.	Surveyor to the District Highway Board, Mortlake.
Robinson, J.	County Surveyor, Hampshire.
Robson, O. C., A.M.I.C.E. *(Member of Council.)*	Surveyor to the Local Board, Willesden, Middlesex; *Hon. Secretary*, Home Counties District.
Ruck, F. W.	County Surveyor, Kent, Maidstone.
Savage, Wm. Hy.	Surveyor to the Local Board, East Ham.
Scoones, W. G.	Borough Surveyor, Maidstone.
Scott, H. H., A.M.I.C.E.	Engineer to the Commissioners, Hove.
Scott, R. S.	Surveyor to the Local Board, Bishop's Stortford.
Smith, I. C.	Surveyor to the Rural Sanitary Authority, Chelmsford.
Smythe, F.	Local Board, Finchley, N.
Southam, A., A.M.I.C.E.	Surveyor, Clapham, London, S.W.
Stallard, S.	Surveyor to the Rural Sanitary Authority, Maidstone.
Stevenson, J.	Surveyor to the Local Board, East Molesey.
Stickland, E. A., A.M.I.C.E.	Borough Surveyor, Newbury.
Strachan, G. R., A.M.I.C.E.	Late Surveyor, Chelsea. Clovelly, Byne Road, Balham, S.W.
Strachan, J. H.	Surveyor to the Local Board, Brentford.
Stringfellow, H. W.	City Surveyor, Chichester.
Sumner, F.	Surveyor to the Vestry, Bermondsey.

Terrill, W.	Surveyor to the Local Board, Ashford, Kent.
Thomas, W., A.M.I.C.E.	Borough Surveyor, Dover.
Towlson, S.	Surveyor to the Local Board, Erith.
Valon, W. A., McIntosh, A.M.I.C.E.	Ramsgate Corporation Gas Works Engineer. Connaught Mansions, Victoria Street, S.W.
Ventris, A., A.M.I.C.E.	Surveyor to the Strand District Board of Works. 5, Tavistock Street, Covent Garden.
Walker, T., M.I.C.E. *(Member of Council.)*	Borough Surveyor, Croydon, Surrey.
Wallace, G.	Surveyor to St. Giles District Board of Works.
Waterhouse, D.	Surveyor to the Local Board, Watford.
Watts, E. T.	Surveyor to the Rural Sanitary Authority, Bishop's Stortford.
Weaver, Wm., M.I.C.E.	Surveyor to the Vestry, Kensington.
Weston, Geo.	Surveyor to the Vestry, Paddington.
Weston, H. J., A.M.I.C.E.	Surveyor to the Local Board, Shirley and Freemantle, Southampton.
Wheeler, G. R. W., Assoc. M.I.C.E.	Surveyor to the Vestry, Westminster.
WHITE, W. H., M.I.C.E. *(Past President.)*	City Engineer, Oxford.
Whitmore, F.	County Surveyor, Chelmsford.
Winship, G., A.M.I.C.E.	Borough Surveyor, Abingdon, Berks.
Woodbridge, C. A.	Surveyor to the Hendon Union Rural Sanitary Authority.
Worth, J. E., A.M.I.C.E.	Engineer to the Local Board, Tottenham.

TOWNS.

Abingdon	G. Winship.
Acton	D. J. Ebbetts.
Alverstoke	W. H. Fry.
Aylesbury	G. Cannon.
Barking	C. J. Dawson.
Battersea	J. T. Pilditch.
Banbury	S. E. Burgess.
Bedford	J. Lund.
„ (County)	W. H. Leete.
Bermondsey	F. Sumner.
Bethnal Green	F. W. Barratt.
Biggleswade	G. W. Manning.
Bishop's Stortford	R. S. Scott.
„ „ (R.S.A.)	E. T. Watts.
Brentford	J. H. Strachan.
Brighton	F. J. C. May.
„	P. C. Lockwood.
Bromley	H. S. Cregeen.
Buckinghamshire (County)	R. J. Thomas.
Canterbury	F. Baker.
Carshalton	T. L. Heward.
Cheshunt	T. Bennett.
Chichester	H. W. Stringfellow
Clapham, S.W.	A. Southam.
Clerkenwell	W. Iron.
Croydon	T. Walker.
„ (Rural)	R. M. Chart.

Dorking	G. S. Mathews.
Dorking (R.S.A.)	W. Rapley, jun.
Dover	W. Thomas.
Ealing	C. Jones.
East Ham	W. H. Savage.
East Molesey	J. Stephenson.
Edmonton	G. E. Eachus.
Epsom	J. R. Harding.
Erith	S. Towlson.
Fareham	W. Butler.
Finchley	F. Smythe.
Friarn Barnet	E. J. Reynolds.
Fulham	J. P. Norrington.
Guildford	F. T. Maltby.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Hampshire (County)	J. Robinson.
Hampton	J. Kemp.
Hanwell	S. W. J. Barnes.
,,	E. J. W. Herbert.
Harrow	E. R. Capon.
Hastings	P. H. Palmer.
Hendon	S. S. Grimley.
,, (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Hertford	T. R. Dickinson.
Heston and Isleworth	W. B. Bromley.
Hornsey	T. De C. Meade.
Hounslow	W. B. Bromley.
Hove	H. H. Scott.
Kensington	W. Weaver.
Kent (County)	F. W. Ruck.
Kingston (Highway Board)	A. J. Henderson.
,, (Rural)	W. H. Hope.
Lewes	A. Holt.
Lewisham	J. Carline.
Leyton, E.	W. Dawson.
London (County)	A. R. Binnie.
Maidstone	W. G. Scoones.
,, (Rural)	S. Stallard.
Milton-next-Sittingbourne	A. B. Acworth.
Mortlake	H. Richards.
New Barnet	G. W. Brumell.
Newbury	E. A. Stickland.
New Malden	T. L. Heward.
Oxford	W. H. White.
Paddington	Geo. Weston.
Plumstead	W. G. Forder.
Poplar	G. F. Holt.
Portsmouth	P. Murch.
Putney	J. C. Radford.

Ramsgate	W. A. M. Valon.
Reading	A. E. Collins.
„	A. W. Parry.
Richmond	E. J. Lovegrove.
Rochester	W. Banks.
Ryde	F. Newman.
Sevenoaks	J. Mann.
Shirley and Freemantle	H. J. Weston.
Slough	J. Baker.
Southampton	W. B. G. Bennett.
„	J. Lemon.
Southend-on-Sea	P. Dodd.
Southgate	C. G. Lawson.
South Hornsey	M. W. Jameson.
Strand	A. Ventris.
Streatham	Jas. Barber.
St. George the Martyr, Southwark	A. M. Hiscocks.
St. George's, Hanover Square	G. Livingstone.
St. Giles	G. Wallace.
St. Luke, Middlesex	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrich.
Sussex (E.) (County)	Hy. Card.
Sussex (W.) (County)	C. Adcock.
Sutton, Surrey	E. W. Crickmay.
Tooting	Jas. Barber.
Tottenham	J. E. Worth.
Twickenham	G. B. Laffan.
Ventnor	E. J. Harvey.
„	J. G. Livesay.
Walthamstow	G. W. Holmes.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Watford	D. Waterhouse.
„ (Rural)	G. A. Heath.
West Cowes	N. F. Dennis.
West Ham, London	L. Angell.
Westminster	G. R. W. Wheeler.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Woodford	J. D. Hooper.
Wood Green	C. J. Gunyon.
„	C. L. Walker.
Worthing	M. Aspinall.

No. 2.—THE MIDLAND DISTRICT.

Hon. Secretary—A. T. Davis, Shire Hall, Shrewsbury.

MEMBERS.

Allen, T. T.	Broad Street, Stratford-on-Avon.
Ault, W. F.	Surveyor to the Rural Sanitary Authority, Billesdon, Leicester.
Beckley, J. W.	Town Surveyor, Brierley Hill.
Berrington, R. E. W., A.M.I.C.E.	Borough Engineer, Wolverhampton.
Bettany, F.	Borough Engineer, Burslem.
Bishop, McW.	Surveyor to the Local Board, Sutton-in-Ashfield, Notts.
Blackshaw, W., A.M.I.C.E.	Borough Surveyor, Stafford.
Brettell, W. H.	Surveyor to the Local Board, Rowley Regis, Staffordshire.
Brierley, J. H.	Surveyor to the Local Board, Rugby.
Brown, Arthur, M.I.C.E. (*Member of Council*).	Borough Engineer, Nottingham.
Brown, W. T.	Surveyor to the Rural Sanitary Authority, Worksop.
Campbell, A. H.	Borough Surveyor, Stratford-on-Avon.
Chipperfield, W. R. H., A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Atherstone, Warwickshire.
Clarson, H. J.	Borough Surveyor, Tamworth.
Coales, H. G., A.M.I.C.E.	Surveyor to the Local Board, Market Harborough.
Comber, A.	Borough Surveyor, Kidderminster.
Cooper, W. W.	Surveyor to the Local Board, Hinckley.
Corrie, C. J.	City Surveyor, Lichfield.
Currall, A. E.	Surveyor to the Rural Sanitary Authority, Solihull, Warwickshire.
Davies, W. A., A.M.I.C.E.	Surveyor to the Local Board, Aston Manor.
Davis, A. T., A.M.I.C.E. (*Member of Council.*)	County Surveyor, Salop; *Hon. Secretary*, Midland Counties District.
De Normanville, W., A.M.I.C.E.	Borough Surveyor, Leamington Spa.
Dixon, R.	Surveyor to the Local Board, Harborne.
Eayrs, J. T., A.M.I.C.E. (*Vice-President.*)	Borough Surveyor, West Bromwich.
Eddowes, W. C.	Borough Surveyor, Shrewsbury.
Fiddian, W.	Town Surveyor, Stourbridge.
Gammage, J.	Borough Surveyor, Dudley.
Garratt, C. T.	Surveyor to the Local Board, Ashby Woulds.
Godfrey, B.	Borough Surveyor, Droitwitch.
Godfrey, R., A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, King's Norton. King's Heath, near Birmingham.
Griffiths, F.	Corporation Waterworks Engineer, Leicester.
Hammonds, G. B.	Surveyor to the Local Board, Newport, Salop.
Harrison, O. E.	Surveyor to the Local Board, Worksop.

Hawgood, R. H.	Surveyor to the Rural Sanitary Authority, Aston.
Hawley, G. W.	Surveyor to the Local Board, Beeston, Notts.
Hodson, George, M.I.C.E.	Loughborough.
Hooley, E. P., A.M.I.C.E.	County Surveyor, Nottingham.
Jeeves, Ed.	Surveyor to the Local Board, Melton Mowbray.
Jukes, W. H.	Surveyor to the Local Board, Tipton.
Kennedy, J. D.	Town Surveyor, Retford.
Kilford, H. J.	Borough Surveyor, Ilkeston, Derbyshire.
Law, E.	County Surveyor, Northampton.
Law-Green, C.	Waterworks, Oundle.
Lilley, G. H.	Surveyor to the Local Board, Ashley-de-la-Zouche.
LOBLEY, J., M.I.C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
Marston, C. F., A.M.I.C.E.	Borough Surveyor, Sutton Coldfield.
Mawbey, E. G., A.M.I.C.E.	Borough Engineer, Leicester.
Mawson, R. C.	Borough Surveyor, Evesham.
Metcalf, J. W.	Surveyor to the Rural Sanitary Authority, Ashby-de-la-Zouche.
Middleton, R. H.	Borough Surveyor, Walsall.
Molineux, W. F. T.	Town Surveyor, Shifnal, Salop.
Mortimer, J.	Surveyor to the Local Board, Tettenhall, near Wolverhampton.
Myatt, J.	Town Surveyor, Leek.
Parker, J., A.M.I.C.E.	Surveyor to the Basford Union Rural Sanitary Authority, Nottingham.
Parker, J., A.M.I.C.E.	City Surveyor, Hereford.
Pattison, J., jun.	Borough Surveyor, Newcastle-under-Lyme.
Pickering, J. S.	Surveyor to the Local Board, Nuneaton.
PRITCHARD, E., M.I.C.E. (*Past President.*)	37, Waterloo Street, Birmingham.
Purnell, E. J.	City Surveyor, Coventry, Warwickshire.
Richardson, H., A.M.I.C.E.	Surveyor to the Local Board, Oldbury.
Ridout, A. R.	Surveyor to the Local Board, Wirksworth.
Shackleton, C. W.	Surveyor to the Local Board, Coseley.
Sharman, E.	Surveyor to the Local Board, Wellingborough, Northamptonshire.
Shaw, J. H.	Surveyor to the Local Board, Brownhills, Staffordshire.
Shepherd, G. J.	Highway Surveyor, Kidderminster.
Siddons, J. M.	Town Surveyor, Oundle.
Simpson, J.	Wirksworth, Derbyshire.
Simpson, W. H., A.M.I.C.E.	Surveyor to the Blaby Union R.S.A., Leicester.
Smith, T. R.	Surveyor to the Local Board, Kettering.
Stuart, J. C.	Surveyor to the Local Board, Smethwick.
Swindlehurst, J. E., Assoc. M.I.C.E.	Borough Surveyor, Burton-upon-Trent.
Thomas, R. J.	County Surveyor, Bucks, Aylesbury.
TILL, W. S., M.I.C.E. (*Past President*).	Borough Engineer, Birmingham.
Vallance, R. F.	Town Surveyor, Mansfield.

Wakelam, H. T., A.M.I.C.E.	County Surveyor, Hereford.
Walshaw, J. W.	Borough Surveyor, Peterborough.
Wardle, J. W., A.M.I.C.E.	Borough Surveyor, Longton.
Whitbread, R.	Surveyor to the Local Board, Carlton, Notts.
Willcox, J. E., A.M.I.C.E.	118, Colmore Row, Birmingham.
Willmot, J.	County Surveyor, Warwickshire. 6, Waterloo Street, Birmingham.
Wilson, C. L. N.	Town Surveyor, Bilston.
Wood, A. R.	Surveyor to the Local Board, Tunstall.
York, E. A.	95, Upper Walhouse Street, Walsall.

TOWNS.

Ashby-de-la-Zouche	G. H. Lilley.
„ (R.S.A.)	J. W. Metcalf.
Ashby Woulds	C. T. Garratt.
Aston Manor	W. A. Davies.
„ (R.S.A.)	R. H. Hawgood.
Atherstone (R.S.A.)	W. R. H. Chipperfield.
Basford Union (R.S.A.)	J. Parker.
Beeston	G. W. Hawley.
Billesdon (R.S.A.)	W. F. Ault.
Bilston	C. L. N. Wilson.
Birmingham	W. S. Till.
„	E. Pritchard.
Blaby (R.S.A.)	W. H. Simpson.
Brierley Hill	J. W. Beckley.
Brownhills	J. H. Shaw.
Burslem	F. Bettany.
Burton-upon-Trent	J. E. Swindlehurst.
Carlton, Notts.	R. Whitbread.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.
Droitwitch	B. Godfrey.
Dudley	J. Gammage.
Hanley	J. Lobley.
Harborne	R. Dixon.
Hereford	J. Parker.
„ (County)	H. T. Wakelam.
Hinckley	W. W. Cooper.
Ilkeston	H. J. Kilford.
Kettering	T. R. Smith.
Kidderminster	A. Comber.
„	G. J. Shepherd.
King's Norton (R.S.A.)	R. Godfrey.
Leamington Spa	W. De Normanville.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
Lichfield	C. J. Corrie.
Longton	J. W. Wardle.
Loughborough	Geo. Hodson.
Mansfield	R. F. Vallance.
Market Harboro'	H. G. Coales.
Melton Mowbray	E. Jeeves.

Newcastle-under-Lyme	J. Pattison, jun.
Newport, Salop	G. B. Hammonds.
Northampton (County)	E. Law.
Nottingham	A. Brown.
„ (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.
Oldbury	H. Richardson.
Oundle	J. M. Siddons.
Peterborough	J. W. Walshaw.
Retford	J. D. Kennedy.
Rowley Regis	W. H. Brettell.
Rugby	J. H. Brierley.
Shifnal	W. F. T. Molineux.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Smethwick	J. C. Stuart.
Solihull (R.S.A.)	A. E. Currall.
Stafford	W. Blackshaw.
Stourbridge	W. Fiddian.
Stratford-on-Avon	T. T. Allen.
„	A. H. Campbell.
Stretford	H. Royle.
Sutton Coldfield	C. F. Marston.
Sutton-in-Ashfield	McW. Bishop.
Tamworth (R.S.A.)	H. J. Clarson.
Tettenhall	J. Mortimer.
Tipton	W. H. Jukes.
Tunstall	A. R. Wood.
Walsall	R. H. Middleton.
Warwickshire	J. Willmot.
Wellingborough	E. Sharman.
West Bromwich, Staffordshire	J. T. Eayrs.
Wirksworth	J. Simpson.
Wolverhampton	R. E. W. Berrington.
Worksop	O. E. Harrison.

No. 3.—THE YORKSHIRE DISTRICT.

Acting Hon. Secretary—Jas. Howcroft, Redcar.

MEMBERS.

Armstead, Richard, Assoc. M.I.C.E.	Surveyor to the Improvement Commissioners, Bingley, Yorkshire.
Barras, C. C.	Surveyor to the Rural Sanitary Authority, Doncaster.
Brown, R. R.	Surveyor to the Local Board, Bridlington.
Cox, J. H., M.I.C.E. *(Member of Council.)*	Borough Surveyor, Town Hall, Bradford.
Crabtree, W. H. R., Assoc. M.I.C.E.	Borough Surveyor, Doncaster.
Creer, A., A.M.I.C.E.	City Surveyor, York.

Davidson, R., M.I.C.E.	Late Borough Engineer, Sheffield. St. Anne's Chambers, St. Peter's Close, Sheffield.
Dearden, Hy.	Borough Surveyor, Batley.
Dyer, S.	Late Surveyor to the Local Board, Bridlington.
Escott, E. R. S., M.I.C.E. *(Member of Council.)*	Borough Engineer, Halifax.
Gaskell, P.	Surveyor to the Local Board, Hornsea, near Hull.
Gledhill, T.	Town Surveyor, Heckmondwike, Yorkshire.
Hare, F. H.	Surveyor to the Local Board, Mirfield.
Hewson, T., M.I.C.E. *(Vice-President.)*	Borough Engineer, Leeds.
Hikeley, G. S.	Surveyor to the Local Board, Saltburn-by-the-Sea.
Hopkinson, W. H.	Borough Engineer, Keighley.
Howcroft, James *(Member of Council.)*	Surveyor, Kirkleatham Local Board, Redcar, Yorkshire; *Hon. Sec.*, Northern Counties District.
Humphries, T.	Town Surveyor, Mexborough.
Jennings, G.	Borough Surveyor, Rotherham.
Latham, E. D., A.M.I.C.E.	Borough Surveyor, Middlesbrough, Yorkshire.
Mallinson, T.	Surveyor to the Local Board, Selby.
Marks, H. C., A.M.I.C.E.	Borough Engineer, Dewsbury.
Massie, F., A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Wakefield.
Oxtoby, W.	Borough Surveyor, Beverley.
Penty, W. G.	Surveyor to the Rural Sanitary Authority, York.
Petch, J.	Borough Surveyor, Scarborough.
Porter, R.	Borough Surveyor, Wakefield.
Robinson, W. P.	Surveyor to the Local Board, Skelton-in-Cleveland.
Ross, P., A.M.I.C.E.	Surveyor to the Local Board, North Bierley, Bradford.
Rothera, F.	Surveyor to the Local Board, Sowerby Bridge.
Stainthorpe, T. W.	Surveyor to the Eston District Local Board, Yorkshire.
Stead, S.	Borough Surveyor, Harrogate.
Wike, C. F., M.I.C.E. *(Member of Council.)*	Borough Engineer, Sheffield.

TOWNS.

Batley	Hy. Dearden.
Beverley	W. Oxtoby.
Bingley	R. Armistead.
Bradford	J. H. Cox.
Bridlington	R. R. Brown.
,,	S. Dyer.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
,, (Rural)	C. C. Barras.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.

Halifax	E. R. S. Escott.
Harrogate	S. Stead.
Heckmondwike	T. Gledhill.
Hornsea	P. Gaskell.
Hull	A. E. White.
Keighley	W. H. Hopkinson.
Kirkleatham	J. Howcroft.
Leeds	T. Hewson.
Mexborough	T. Humphries.
Middlesbrough	E. D. Latham.
Mirfield	F. H. Hare.
North Bierley	P. Ross.
Ripon	T. Kidd.
Rotherham	G. Jennings.
Saltburn-by-the-Sea	G. S. Hickley.
Scarborough	J. Petch.
Selby	T. Mallinson.
Sheffield	C. F. Wike.
„	R. Davidson.
Skelton-in-Cleveland	W. P. Robinson.
Sowerby Bridge	F. Rothera.
Todmorden	H. Shaw.
„	A. Greenwood.
Wakefield	R. Porter.
„ (Rural)	F. Massie.
West Hartlepool	J. W. Brown.
Worksop (R.S.A.)	W. T. Brown.
York	A. Creer.
„ (Rural)	W. G. Penty.

No. 4.—THE LANCASHIRE AND CHESHIRE DISTRICT.

Hon. Secretary—S. S. Platt, Town Hall, Rochdale.

MEMBERS.

Atkinson, J., A.M.I.C.E.	Borough Surveyor, Stockport.
BOULNOIS, H. P., M.I.C.E. (*Past President.*)	City Engineer, Liverpool.
Brierley, R.	Town Surveyor, Newton-in-Makerfield, Lancashire.
Brockbank, W. Hy.	Borough Surveyor, Bolton.
Broom, G. J. C., A.M.I.C.E.	Borough Engineer, St. Helen's, Lancashire.
Burslam, R.	Borough Surveyor, Congleton.
Burton, J. H.	Surveyor to the Local Board, Audenshaw, Lancashire.
Button, F. S., A.M.I.C.E.	Borough Surveyor, Burnley.
CARTWRIGHT, J., M.I.C.E. (*President.*)	Borough Surveyor, Bury, Lancashire.

Cook, J.	Borough Surveyor, Lancaster.
Crabtree, W., M.I.C.E.	Borough Surveyor, Southport.
Crowther, J. A.	Borough Surveyor, Bootle, Lancs.
Dent, William	Late Surveyor to the Local Board, Nelson-in-Marsden, Lancashire. Railway Street, Nelson.
Diggle, Jas., A.M.I.C.E.	Borough Engineer, Heywood.
Diggle, Wm.	Surveyor, Frodsham, Chester.
Dixon, Isaac	Surveyor to the Local Board, Wavertree.
Earnshaw, J. T., A.M.I.C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
Eaton-Shore, G., A.M.I.C.E.	Borough Surveyor, Crewe.
Edmundson, S.	Surveyor to Rural Sanitary Authority, Burnley.
Fowler, A. M., M.I.C.E.	Stockport.
Fraser, A. O.	Surveyor to the Local Board, Allerton, Liverpool.
Gaulter, M. S.	Town Surveyor, Fleetwood.
Goldsworth, W.	Surveyor to the Local Board, Prescot, Lancashire.
Greenwood, A.	Late Surveyor to the Local Board, Todmorden.
Gregson, J., A.M.I.C.E.	Surveyor to the Local Board, Padiham, near Burnley.
Hall, W., A.M.I.C.E.	Surveyor to the Local Board, Great Crosby.
Heaton, Geo., A.M.I.C.E.	Surveyor to the Local Boards, Pemberton, Aspull, Abram, and Orrell. King Street, Wigan.
Higginson, T.	28, Deacon Road, Appleton, Widnes.
Hooley, Cosmo C., Assoc. M.I.C.E.	Rural Sanitary Authority, Barton-upon-Irwell, Patricroft.
Jones, I. M., A.M.I.C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
Landless, J. T.	Surveyor to the Local Board, Brierfield, Lancs.
Lomax, C. Jas.	Engineer to the Failsworth Local Board, Lancashire.
Mallinson, J.	Surveyor to the Local Board, Colne, Lancashire.
Mawson, Jno.	Late Local Board, Shaw, near Oldham.
McBeath, A. G., A.M.I.C.E.	Surveyor to the Local Board, Sale, Cheshire.
McCallum, J. B., M.I.C.E. (*Member of Council.*)	Borough Engineer, Blackburn.
Middlebrook, S.	Surveyor to the Local Board, Walton-on-the-Hill.
Mitchell, J.	Borough Surveyor, Hyde, Manchester.
Mountain, A. H.	Surveyor to the Local Board, Withington, near Manchester.
Newton, G. H.	Surveyor to the Local Board, Denton, Manchester.
Newton, J., M.I.C.E.	Carlton Buildings, Manchester; Engineer to the Local Board, Bowdon, Cheshire.
Newton, W. J., A.M.I.C.E.	Borough Surveyor, Accrington.
Nuttall, T., A.M.I.C.E.	Surveyor to the Local Boards, Kearsley and Ramsbottom, Lancashire. 12, Market Street, Bury, Lancs.
Parkinson, Jas., A.M.I.C.E.	Surveyor to the Local Board, Turton, near Bolton.
Platt, S. S., A.M.I.C.E. (*Member of Council.*)	Borough Surveyor, Rochdale; *Hon. Secretary*, Lancashire and Cheshire District.
Price, John, A.M.I.C.E.	Surveyor to the Local Board, Toxteth Park, Liverpool.
Proctor, J., M.I.C.E.	13, Mawdesley Street, Bolton, Lancashire.

Rothwell, E.	Tramways Co., Rochdale.
Royle, H., A.M.I.C.E.	Surveyor to the Local Board, Stretford, Lancashire.
Salmon, A., A.M.I.C.E.	Surveyor to the Local Board, Wallasey, Cheshire.
Shaw, H., A.M.I.C.E.	Surveyor to the Local Board, Todmorden.
Shaw, J.	Surveyor to the Local Board, Swinton, Manchester.
Sheard, W. C.	Surveyor to the Local Board, Heaton Norris.
Sinclair, J. S.	Surveyor to the Local Board, Widnes.
Smith, C. C.	Surveyor to the Local Board, Dalton-in-Furness.
Spinks, W., A.M.I.C.E.	Late Surveyor to the Local Board, Dukinfield. 9, Albert Square, Manchester.
Stokoe, J.	Surveyor to the Local Board, Altrincham.
Stubbs, Wm., A.M.I.C.E.	Borough Surveyor, Darwen.
Swarbrick, Joseph, Assoc. M.I.C.E.	44, Brasenose Street, Albert Square, Manchester.
Sykes, Ed., A.M.I.C.E.	Late Surveyor to the Local Board, Cheadle, Manchester.
Thompson, R.	Surveyor to the Local Board, Waterloo, near Liverpool.
Thorburn, T. C.	Borough Surveyor, Birkenhead.
Thorpe, Jas.	Surveyor to the Rural Sanitary Authority, Macclesfield.
Veevers, H., A.M.I.C.E.	Surveyor to the Local Board, Dukinfield.
Welburn, W.	Borough Surveyor, Middleton, near Manchester.
Wild, G. H.	Surveyor to Local Board, Littleborough, near Manchester.
Wilkinson, J. P., A.M.I.C.E.	Assheton Road, Clayton Bridge, Manchester.
Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Window, E. R., A.M.I.C.E.	Late Surveyor to the Local Board, Bishop's Stortford. 16, Cook Street, Liverpool.
Yates, F. S., A. M. Inst. C.E.	Surveyor to the Local Board, Waterloo, near Liverpool.

TOWNS.

Abram	Geo. Heaton.
Accrington	W. J. Newton.
Allerton	A. O. Fraser.
Altrincham	J. Stokoe.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	Geo. Heaton.
Audenshaw	J. H. Burton.
Bacup	J. Wilson.
Barton-upon-Irwell (Rural)	C. C. Hooley.
Birkenhead	T. C. Thorburn.
Blackburn	J. B. McCallum.
Bolton	W. H. Brockbank.
„	J. Proctor.
Bootle	J. A. Crowther.
Bowdon	J. Newton.
Brierfield	J. T. Landless.
Burnley	F. S. Button.
„ (R.S.A.)	S. Edmondson.
Bury	J. Cartwright.

Cheadle	E. Sykes.
Chester	I. M. Jones.
Colne	J Mallinson
Congleton	R. Burslam.
Crewe	G. Eaton-Shore.
Dalton-in-Furness	C. C. Smith.
Darwen	W. Stubbs.
Denton	G. H. Newton.
Dukinfield	H. Veevers.
Failsworth	C. J. Lomax.
Fleetwood	M. S. Gaulter.
Frodsham	W. Diggle.
Great Crosby	W. Hall.
Heaton Norris	W. C. Sheard.
Heywood	J. Diggle.
Hyde	J. Mitchell.
Kearsley	T. Nuttall.
Lancaster	J. Cook.
Littleborough	G. H. Wild.
Liverpool	H. P. Boulnois.
"	G. Biddle.
Macclesfield (R.S.A.)	J. Thorpe.
Manchester	J. Newton.
Middleton, Lancashire	W. Welburn.
Nelson-in-Marsden	W. Dent.
Newton-in-Makerfield	R. Brierley.
Orrell	G. Heaton.
Padiham	J. Gregson.
Pemberton	Geo. Heaton.
Prescot	W. Goldsworth.
Ramsbottom	T. Nuttall.
Rochdale	S. S. Platt.
Sale	A. G. McBeath.
Southport	W. Crabtree.
Stockport	J. Atkinson.
St. Helen's	G. J. C. Broom.
Swinton	J. Shaw.
Toxteth Park	J. Price.
Turton	Jas. Parkinson.
Wallasey	A. Salmon.
Walton-on-the-Hill	S. Middlebrook.
Waterloo, Liverpool	F. S. Yates.
Wavertree	I. Dixon.
Widnes	J. S. Sinclair.
"	T. Higginson.
Withington	A. H. Mountain.

No. 5.—THE WESTERN DISTRICT.

Hon. Secretary—JOSEPH HALL, Town Hall, Cheltenham.

MEMBERS.

ASHMEAD, F., M.I.C.E. (*Past President.*)	Borough Engineer, Bristol.
BELLAMY, G. D., M.I.C.E.	Borough Engineer, Plymouth.
BESWICK, W. H.	Surveyor to the Local Board, Exmouth.
EDINGER, P.	Surveyor to Local Board, Frome.
ELFORD, J.	Borough Surveyor, Poole.
FARRALL, T.	Surveyor to the Local Board, Sherborne, Dorset.
GARRETT, H., A.M.I.C.E.	Town Surveyor, Torquay.
GEEN, H.	Borough Surveyor, Okehampton.
GRAY, W. H.	Borough Surveyor, Tewkesbury, Gloucestershire.
GREENWELL, A.	Surveyor to the Rural Sanitary Authority, Frome.
HALL, JOSEPH, A.M.I.C.E. (*Member of Council.*)	Borough Surveyor, Cheltenham; *Hon. Secretary*, Western Counties District.
HAWKINS, I. T.	Town Surveyor, Somerton, Somersetshire.
HICKES, T. J.	County Surveyor, Cornwall (Western division), Truro.
HODGE, J. L., A.M.I.C.E.	Surveyor to the Local Board, East Stonehouse, Devon.
INGLIS, J. C., M.I.C.E.	Surveyor to the Local Board, Compton Gifford, Devon.
LEWIS, T. L.	Town Surveyor, St. George, Bristol.
MORGAN, W. B., A.M.I.C.E.	Borough Surveyor, Weymouth, and Melcombe Regis, Dorchester.
PHILLIPS, R.	County Surveyor, Gloucester.
POWELL, D. H W.	Town Surveyor, Pontypool.
PRESS, W. J.	Surveyor to the Local Board, Burnham, Somerset.
PROUSE, O. M., A.M.I.C.E.	Surveyor to the Local Board, Ilfracombe.
READ, RICHARD, A.M.I.C.E.	City Surveyor, Gloucester.
SADLER, G. W.	Late Surveyor to the Sanitary Authority, Cheltenham.
SAISE, A. J.	Surveyor to the Local Board, Stapleton, Bristol.
STEVENS, GEORGE	Local Board, Blaina, Mon.
STEVENS, L.	Surveyor to the Local Board, Newton Abbott, Devon.
TANNER, W.	County Surveyor, Monmouthshire. Newport.
WEBSTER, J. L.	Surveyor to the Local Board, Portland.
WIDLOWSON, W. C.	Surveyor to the Local Board, Tredegar, Mon.
WYATT, W. J.	Surveyor to the Local Board, Paignton, Devon.

TOWNS.

Abergavenny	Jon. Haigh.
Blaina	G. Stevens.
Bournemouth	F. W. Lacey.
Bristol	F. Ashmead.
Burnham, Somerset	W. J. Press.
Cheltenham	Jos. Hall.
„	G. W. Sadler.
Compton Gifford	J. C. Inglis.
Cornwall (County), W.	T. J. Hickes.
East Stonehouse	J. C. Hodge.
Exmouth	W. H. Beswick.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.
Gloucester	R. Read.
„ (County)	R. Phillips.
Ilfracombe	O. M. Prouse.
Monmouthshire (County)	W. Tanner.
Newton Abbott	L. Stevens.
Okehampton	H. Geen.
Paignton	W. J. Wyatt.
Plymouth	G. D. Bellamy.
Pontypool	D. H. W. Powell.
Poole	J. Elford.
Portland	J. L. Webster.
Sherborne	T. Farrall.
Somerton	I. T. Hawkins.
St. George, Bristol	T. L. Lewis.
Tewkesbury, Gloucestershire	W. H. Gray.
Torquay	H. A. Garrett.
Tredegar	W. C. Widdowson.
Weymouth and Melcombe Regis	W. B. Morgan.

No. 6.—THE NORTHERN DISTRICT.

Hon. Secretary—Jas. Howcroft, Redcar.

MEMBERS.

Anderson, R. S., A.M.I.C.E.	County Surveyor, Peebles, N.B.
Beatson, W.	Borough Surveyor, Leith.
Bower, Jas.	Borough Engineer, Gateshead-on-Tyne.
Brodie, J. S., A.M I.C.E.	Town Surveyor, Whitehaven.
Brown, Jos. W., A.M.I.C.E.	Borough Engineer, West Hartlepool.

Campbell, K. F., A.M.I.C.E.	Borough Surveyor, Stockton.
Cooper, J., A.M.I.C.E. (*Member of Council.*)	Burgh Engineer, Edinburgh.
Copland, C. A.	Town Surveyor, Bedlington.
Crummack, H. C., A.M.I.C.E.	Borough Surveyor, Hartlepool.
Dyack, W.	Burgh Surveyor, Aberdeen.
Edge, F. J., A.M.I.C.E.	Surveyor to the Local Board, Cleator-Moor.
Foster, T.	Surveyor to the Local Board, Houghton-le-Spring.
Gregson, G.	Surveyor to the Rural Sanitary Authority, Durham.
Grieves, R.	Surveyor to the Local Board, Hexham,
Hall, M.	Borough Surveyor, South Shields, Durham.
Hepworth, J., M.I.C.E.	Engineer to the Gas and Waterworks of the Corporation of Carlisle.
Hollings, G.	Surveyor to the Local Board, Wallsend.
LAWS, W. G., M.I.C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
Marsh, R. S.	Surveyor to the Local Board, Cockermouth.
Mason, W. A.	Surveyor to the Local Board, Shildon, near Darlington.
Petree, J.	Borough Surveyor, Jarrow.
Pickering, Richard	11, Lowther Street, Whitehaven.
Rounthwaite, R. S.	Borough Engineer, Sunderland.
Smith, W. Howard, Assoc. M.I.C.E.	City Engineer, Carlisle.
Spencer, J. P., A.M.I.C.E.	32, Moseley Street, Newcastle-on-Tyne.
Turnbull, A. J.	Borough Engineer, Greenock.
Watson, J. D., A.M.I.C.E.	County Sanitary Engineer, Aberdeenshire.
Waye, H.	Surveyor to the Local Board, Millom, Cumberland.
Wilson, Geoffrey	Surveyor to the Local Board, Alnwick.
Wilson, J. B.	Surveyor to the Rural Sanitary Authority, Cockermouth.

TOWNS.

Aberdeen	W. Dyack.
Aberdeenshire	J. D. Watson.
Alnwick	G. Wilson.
Ayrshire	A. Stevenson.
Bedlington	C. A. Copland.
Carlisle	W. H. Smith.
„	J. Hepworth.
Cleator Moor	F. J. Edge.
Cockermouth	R. S. Marsh.
„ (R.S.A.)	J. B. Wilson.
Durham (R.S.A.)	G. Gregson.
Edinburgh	J. Cooper.

Gateshead-on-Tyne	J. Bower.
Greenock	A. J. Turnbull.
Hartlepool	H. C. Crummack.
Hexham	R. Grieves.
Houghton-le-Spring	T. Foster.
Jarrow	J. Petree.
Leith	W. Beatson.
Millom	H. Waye.
Newcastle-on-Tyne	W. G. Laws.
,,	J. P. Spencer.
Peebles	R. S. Anderson.
Shildon	W. A. Mason.
South Shields	M. Hall.
Stapleton	A. J. Saise.
Stockton	K. P. Campbell.
Sunderland	R. S. Rounthwaite.
Wallsend	G. Hollings.
Whitehaven	J. S. Brodie.
,,	R. Pickering.

No. 7.—THE EASTERN DISTRICT.

Hon. Secretary—E. Buckham, Town Hall, Ipswich.

MEMBERS.

Bland, D.	Surveyor to the Local Board, Chesterton, Cambridge.
Buchan, J., A.M.I.C.E.	City Engineer, Norwich.
Buckham, E., M.I.C.E. (*Member of Council.*)	Borough Surveyor, Ipswich; *Hon. Secretary*, Eastern Counties District.
Clare, J.	Surveyor to the Local Board, Sleaford.
Cockrill, J. W., A.M.I.C.E.	Borough Surveyor, Great Yarmouth.
Evans, J.	Borough Surveyor, Grantham.
Gooodyear, H., A.M.I.C.E.	Borough Surveyor, Colchester.
Hamby, G. H.	Borough Engineer, Lowestoft.
Horton, G. S.	Surveyor to the Local Board, Felixstowe.
Hutchinson, R.	Borough Surveyor, Huntingdon.
Jevons, J. H.	Surveyor to the Local Board, Braintree.
MacBrair, R. A., A.M.I.C.E.	City Engineer, Lincoln.
Macdonald, D. G., Assoc. M.I.C.E.	Surveyor to the Local Board, Gainsborough.
Marshall, P. P.	Late City Engineer, Norwich.
McKelvie, W., A.M.I.C.E.	City Surveyor, Ely.
Moore, G. J.	City Surveyor, Wisbech.
Richardson, Jas.	Urban Sanitary Authority, Stamford.
Rush, J.	Borough Surveyor, Eye, Suffolk.

Sasse, G. H.	Borough Surveyor, Chelmsford.
Scott, A. F.	Surveyor to the Local Board, Cromer.
Silcock, E. J., A.M.I.C.E.	Borough Surveyor, King's Lynn.
Stewart, A.	Surveyor to the Rural Sanitary Authority Maldon, Essex.
Taylor, H. W.	Surveyor to the Local Board, Newmarket.
Wallis, T. W.	Borough Surveyor, Louth, Lincoln.
White, A. E., A.M.I.C.E.	Borough Engineer, Hull.

TOWNS.

Braintree	J. H. Jevons.
Chelmsford	G. H. Sasse.
„ (R.S.A.)	I. C. Smith.
Chesterton	D. Bland.
Colchester	H. Goodyear.
Cromer	A. F. Scott.
Ely	W. McKelvie.
Essex (County)	F. Whitmore.
Eye	J. Rush.
Felixstowe	G. S. Horton.
Gainsborough	D. G. Macdonald.
Grantham, Lincolnshire	J. Evans.
Great Yarmouth	J. W. Cockrill.
Harwich	H. Ditcham.
Huntingdon	R. Hutchinson.
Ipswich	E. Buckham.
Isle of Ely (County)	G. J. Moore.
King's Lynn	E. J. Silcock.
Lincoln	R. A. MacBrair.
Louth, Lincoln	T W. Wallis.
Lowestoft	G. H. Hamby.
Maldon (R.S.A.)	A. Stewart.
Newmarket	H. W. Taylor.
Norwich	J. Buchan.
Sleaford	Jesse Clare.
Stamford	Jas. Richardson.
Suffolk (County)	J. Rush.

No. 8.—THE DISTRICT OF WALES.

Hon. Secretaries (North)—J. W. M. Smith, Town Hall, Wrexham.
(South)—W. E. C. Thomas, Neath.

MEMBERS.

Baugh, A. C.	Surveyor to the Rural Sanitary Authority, Wrexham.
Bell, Geo.	Borough Surveyor, Swansea.
Coverley, J. S.	Surveyor to the Local Board, Penmaenmawr.

Davies, R.	Borough Surveyor, Brecknock.
Davies, R. W.	Surveyor to the Local Board, Newtown.
Fraser, W., A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Cardiff.
Haigh, Jon., A.M.I.C.E.	Town Surveyor, Abergavenny.
Holden, Jas.	Surveyor to the Highway Board, Llandaff.
Hughes, Robt.	Town Surveyor, Rhyl, Flintshire.
Jones, A. S., Lt.-Col., 𝔙.ℭ.	Engineer to the Urban Sanitary Authority, Wrexham.
Jones, W.	Surveyor to the Local Board, Colwyn Bay.
Marks, T. T., A.M.I.C.E.	Late Town Surveyor, Llandudno, Carnarvonshire.
Morgan, J.	Surveyor to the Pontardawe Rural Sanitary Authority, Swansea.
Roberts, R. O. W.	Borough Engineer, Carnarvon.
Smith, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District (North).
Stephenson, E. P.	Town Surveyor, Llandudno.
Thomas, John, A.M.I.C.E.	Surveyor to the Rural Sanitary Authority, Swansea.
Thomas, T. J., A.M.I.C.E.	Surveyor to the Local Board, Ebbw Vale.
Thomas, W.	Surveyor to the Margam Local Board, Port-Talbot, S. Wales.
Thomas, W. E. C., A.M.I.C.E. (*Member of Council.*)	Surveyor to the Rural Sanitary Authority, Neath; *Hon. Secretary*, Wales District (South).
Watkeys, G.	Surveyor to the Local Board, Llanelly.

TOWNS.

Brecknock	R. Davies.
Cardiff (Rural)	W. Fraser.
Carnarvon	R. O. W. Roberts.
Colwyn Bay	W. Jones.
Ebbw Vale	T. J. Thomas.
Llandaff	Jas. Holden.
Llandudno	E. P. Stephenson.
„	T. T. Marks.
Llanelly	G. Watkeys.
Margam	W. Thomas.
Neath (R.S.A.)	W. E. C. Thomas.
Newtown	R. W. Davies.
Penmaenmawr	J. S. Coverley.
Pontardawe (Rural)	J. Morgan.
Rhyl	Robt. Hughes.
Swansea	G. Bell.
„ (Rural)	J. Thomas.
Wrexham	J. W. M. Smith.
„	A. S. Jones.
„ (Rural)	A. C. Baugh.

No. 9.—THE IRISH DISTRICT.

Hon. Secretary—R. H. Dorman, Armagh.

MEMBERS.

Berry, J., M.I.C.E.,I.	Town Surveyor, Kingstown, Co. Dublin.
Bretland, J. C., M.I.C.E.	City Surveyor, Belfast.
Brett, J. H.	County Surveyor, Co. Antrim, Belfast, Ireland.
Burchaell, P.	County Surveyor, Kilkenny.
Collen, W., M.A., B.E.	County Survey, Dublin (Louth Division). 5, Clanwilliam Place, Dublin.
Comber, P. F., M.I.C.E.,I.	Town Surveyor, Bray. 8, Anglesea Street, College Green, Dublin.
Cowan, P. C.	County Surveyor, Down.
Dorman, R. H. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
Duffin, W. E. L	County Surveyor, Co. Waterford.
Glover, E.	County Surveyor, Co. Kildare.
Gray, R. A.	County Surveyor, Dublin.
Gunnis, J. W.	County Surveyor, Co. Longford.
Hackett, E. A.	County Surveyor, South Tipperary.
Harty, S., M.I.C.E.,I. (*Member of Council.*)	City Engineer, Dublin.
Heron, J.	County Surveyor, Co. Monaghan.
Hill, J., M.I.C.E.	County Surveyor, Clare, Ireland. Ennis.
Horan, J.	County Surveyor, Co. Limerick.
Jackson, N.	County Surveyor, Co. Cork (West Riding), Bandon, Co. Cork.
Kirkby, S. A.	County Surveyor, Co. Cork.
Lynam, P. J.	County Surveyor, Louth. Dundalk, Ireland.
Lyons, A. O.	County Surveyor, Co. Cork (East).
Moore, J. H.	County Surveyor, Meath.
Moynan, J. O.	County Surveyor, North Tipperary.
Orchard, W. P., B.E.	County Surveyor, North Mayo, Ireland.
Ottley, D. G.	County Surveyor, Co. Leitrim.
Perry, J.	County Surveyor, Galway (W. Riding).
Robinson, W. J., A.M.I.C.E.	City Surveyor, Londonderry.
Sanders, R. B.	County Surveyor, King's County.
Shillington, H.	Town Surveyor, Lurgan.
Smith, J.	County Surveyor, Co. Galway (East Riding).
Somerville, R. N., B.E.	County Surveyor, Cavan, Ireland.
White, H. V.	County Surveyor, Queen's Co.
Willson, F. R. T.	County Surveyor, Co. Fermanagh.

TOWNS.

Antrim (County)	J. H. Brett.
Armagh (County)	R. H. Dorman.
Belfast	J. C. Bretland.
Bray	P. F. Comber.
Cavan (County)	R. N. Somerville, B.E.
Clare (County)	J. Hill.
Cork (County)	N. Jackson.
„ „	S. A. Kirkby.
„ „	A. O. Lyons.
Down (County)	P. C. Cowan.
Dublin	S. Harty.
„ (County)	R. A. Gray.
„ „ South division	W. Collen.
Fermanagh (County)	F. R. T. Willson.
Galway (County), E. Riding	J. Smith.
„ „ W. Riding	J. Perry.
Kildare (County)	E. Glover.
Kilkenny (County)	P. Burtchaell.
King's (County)	R. B. Sanders.
Kingstown	J. Berry.
Leitrim (County)	D. G. Ottley.
Limerick (County)	J. Horan.
Lodonderry	W. J. Robinson.
Longford (County)	J. W. Gunnis.
Louth (County)	P. J. Lynam.
Lurgan	H. Shillington.
Meath (County)	J. H. Moore.
Monaghan (County)	J. Heron.
North Mayo (County)	W. P. Orchard.
North Tipperary	J. O. Moynan.
Queens (County)	H. V. White.
South Tipperary	E. A. Hackett.
Waterford (County)	W. E. L. Duffin.

No. 10—ABROAD.

MEMBERS.

Andrews, G. R.	Johannesburg.
Cairncross, T. W.	City Engineer, Capetown.
Deverell, T. C., A.M.I.C.E.	Borough Engineer, South Brisbane, Queensland.
Irving, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.

Kirk, Thos., A.M.I.C.E. ..	Brisbane, Queensland.
Mayne, C.	Engineer and Surveyor, Municipal Council, Shanghai.
Peirce, R.	Municipal Engineer, Penang Straits Settlements.
Richards, R. W.	City Surveyor, Sydney, N.S.W.
St. George, Percival, M.Inst. C.E	City Engineer, Montreal, Canada.

TOWNS.

Brisbane, Queensland	T. Kirk.
Cape Town	T. W. Cairncross.
Johannesburg	A. R. Andrews.
Montreal, Canada	P. St. George.
Penang Straits Settlements	R. Peirce.
Shanghai, China	C. Mayne.
South Brisbane	T. C. Deverell.
Sydney (N.S.W.)	R. W. Richards.
Toowong, Queensland	W. E. Irving.

ISLE OF MAN.

Taylor, T. G.	Town Surveyor, Douglas, Isle of Man.

GRADUATES.

Andrews, C. P.	19, Northwood Road, Highgate.
Ball, B.	Middleton, near Manchester.
Ball, C. F.	Borough Engineer's Office, Bristol.
Ball, Geo.	Borough Surveyor's Office, Scarborough.
Bayley, G. H.	Borough Engineer's Office, Salford.
Beynon, J. C. S., A.M.I.C.E.	Royal Chambers, Johannesburg, S.A.
Blizard, J. H., A.M.I.C.E.	Lansdowne House, Southampton.
Bradley, J. W.	Town Hall, Nelson.
Bradshaw, J. B.	17, West Street, Gateshead-on-Tyne.
Bryans, J. G.	Resident Engineer's Office, Calle Piedad, 228, Buenos Aires.
Bryning, W. G.	Borough Surveyor's Office, Wallsall.
Carter, G. F.	Borough Engineer's Office, Leeds.
Catchpole, J. H.	27, Avenue Villas, Avenue Road, Finchley, N.
Cross, F. W., A.M.I.C.E.	72, Corporation Street, Walsall.
Crow, A.	35, Queen Victoria Street, E.C.
Dixon, J. R.	City Surveyor's Office, Carlisle.
Dolamore, F.	Trouville, Avenue Road, Bournemouth.
Fenton, W. C.	Borough Surveyor's Office, Sheffield.
Finch, A. R., A.M.I.C.E.	Town Hall, Kensington.
Fitton, G.	Borough Engineer's Office, Reading.
Franks, T. W.	Town Hall, West Bromwich.
Gibbs, L., A.M.I.C.E.	Surveyor's Office, P.W.D., Hong Kong.
Glass, S. N.	R.S.A., Water Street, Neath.
Greatorex, A.D., A.M.I.C.E.	Assistant Borough Surveyor, Southampton.
Hills, H. J.	27, Park Road, New Wandsworth, S.W.
Houghton, J.	King's Heath, Birmingham.
Hurd, H.	Town Hall, Leyton, E.
Lynam, G. T., A.M.I.C.E.	Borough Surveyor's Office, Burnley.
Manley, J.	County Surveyor's Office, Liskeard.
Mellor, T. E. W.	Town Surveyor's Office, Tunbridge Wells.
Nichols, A. E.	Borough Engineer's Office, Leeds.
Nickols, F. J.	City Surveyor's Office, Carlisle.
Parker, W.	Borough Surveyor's Office, Hereford.
Pritchard, T., A.M.I.C.E.	Town Surveyor's Office, Richmond, Surrey.
Rich, E. W.	Town Hall, Hounslow.
Roberts, F.	48, Dingle Road, Tranmere, Birkenhead.
Saunders, J.	Borough Surveyor's Office, Oldham.
Smith-Saville, R. W., Assoc. M.I.C.E.	Borough Surveyor's Office, Burton-on-Trent.

Taylor, W. J., A.M.I.C.E. .. 1, Rose Road, Southampton.
Tomes, G. B. .. .. 12, Grove Road, Eastbourne.

Ward, F. D., A.M.I.C.E. .. 3, Cobden Street, Welshpool.
Wood, J. W. .. .. 3, Arthur Terrace, Penrith, Cumberland.

Yarwood, Hy... .. .. .. Town Hall, Rochdale.
Young, W. .. .. Town Hall, Salford.

PARLIAMENTARY COMMITTEE.

O. C. Robson, *Chairman.*

Lewis Angell (West Ham).
G. E. Eachus (Edmonton).
E. B. Ellice-Clark (Westminster).
Chas. Jones (Ealing).
T. De C. Meade (Hornsey).
T. Walker (Croydon).

BYE-LAWS.

MEMBERSHIP.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

MEMBERS.

2. Candidates for admission as Members must be Civil Engineers or Surveyors holding chief permanent appointments under any Municipal Corporations, County Councils, or Urban or Rural Sanitary Authorities, and Civil Engineers or Surveyors holding other chief permanent appointments under any Public Authority of the like nature within the United Kingdom, or in the Colonies or foreign countries.

GRADUATES.

3. Candidates for admission as Graduates must be successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association; and as such shall be entitled to attend the General and District Meetings, and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of Proceedings, but shall not be entitled to vote. Graduates shall at their request become Members of the Association when qualified according to Bye-law 2.

HONORARY MEMBERS.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

5. The Members, Graduates, and Honorary Members shall have notice of and the privilege to attend all Meetings, and be entitled to a copy of the Proceedings of the Association as published.

ENTRANCE FEES AND SUBSCRIPTIONS.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay

no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. A Graduate shall not be required to pay an Entrance Fee, either on his becoming a Graduate or on his becoming a Member. Each Graduate shall pay an Annual Subscription of Half a Guinea.

8. All Subscriptions shall be payable in advance, and shall become due on the 1st day of May in each year; and Members elected between the 1st day of January and the 1st day of May in each year, are required to pay an Entrance Fee on Election, their first Subscription being due on the 1st day of May following their Election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Proceedings or Ballot Lists shall be sent to Members or Graduates who are in arrear with their Subscriptions more than twelve months, and whose Subscriptions shall not have been remitted by the Council as hereinbefore provided.

ELECTION OF MEMBERS AND GRADUATES.

11. A recommendation for admission according to Form A for a Member, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than Two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association, may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any Office.

All Elections of Members and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-Laws.

13. A qualified Graduate desirous of becoming a Member

shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E. A Graduate on becoming qualified to be a Member shall cease to be a Graduate.

ELECTION OF PRESIDENT, VICE-PRESIDENTS, AND MEMBERS OF COUNCIL.

14. The Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these, each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last named nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' nominations must be in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' nominations should not reach fifteen, the Council shall have the power to make up the total number of nominations to twenty. Such list of twenty nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Each Member shall be entitled to vote for or erase any of such Nominations or substitute other names, subject in all cases to the limits of Clause 25 in the Articles of Association, and return the same within seven days from the date of issue. Such Ballot Papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of Council shall be considered ineligible for Election.

APPOINTMENT AND DUTIES OF OFFICERS.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of

resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President); to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

Examinations.

18. Two examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and the Public Health Acts, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be 12 in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

Miscellaneous.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

NINETEENTH ANNUAL MEETING.

Bury, *July* 21*st*, 22*nd*, *and* 23*rd*, 1892.

GENERAL BUSINESS.

The Members assembled in the Council Chamber of the Town Hall (which had been kindly lent for the occasion by the Earl of Derby, K.G.).

The Mayor (Mr. Councillor Ashworth) opened the proceedings by offering to the Association a very hearty welcome to Bury.

Mr. T. De Courcy Meade, the President, then took the chair, and acknowledged the reception given to the Association. The Minutes of the Annual Meeting held in London in June 1891 were then read, confirmed, and signed.

The Secretary then read the Council's Annual Report and Statement of Accounts for the year ending April 30th, 1892.

ANNUAL REPORT.

The Council in resigning the trust committed to its charge has to give an account of its stewardship in the presentation of the Nineteenth Annual Report. In fulfilling this duty on the present occasion no preface is required, the condition of the Association remaining one of healthy vitality and of continued prosperity.

Since the last Annual Meeting in London on the 25th, 26th, and 27th June, 1891, there have been held five District Meetings, viz. at Dublin on the 25th and 26th September, 1891; at Kensington on the 12th of March, 1892; at Nottingham on the 29th and

30th of April; at Peterborough on the 11th of June; and at Scarborough on the 18th of June. The Meeting at Dublin, the second meeting held outside of England, was in every way a very successful one. It opened out a new field in bringing into the Association a considerable number of gentlemen holding the important office of county surveyor. The Council have, in consequence, formed Ireland into a district, and at a meeting of Members in the newly formed district, Mr. R. H. Dorman, the County Surveyor of Armagh, was appointed the Honorary District Secretary. The Council have determined upon a visit to Belfast in the coming autumn, which it is hoped will be as well attended and as keenly appreciated as was the Dublin Meeting. The Kensington Meeting included a visit to the Electrical Exhibition at the Crystal Palace, Sydenham, on the 11th of March. All these District Meetings were very fairly attended, and fully maintain the high position they hold for instructive value and interest.

During the financial year ending April 30th last, 106 new Members, consisting of 94 Ordinary Members and 12 Graduates, have joined the Association, three names have been written off, and the Council regret to report the deaths of M. Alphand, Mr. J. T. Harrison, and M. Van Mierlo, Honorary Members, and Mr. E. Clavey of Burton and J. Willson of Ashford, Ordinary Members.

The number on the roll of the Association at the close of the year was—10 Honorary Members, 454 Ordinary Members, and 39 Graduates, making a total of 503 as against 403 at the end of the previous year.

The audited Balance Sheet, which accompanies this Report, shows a balance in hand on the 30th of April last of 109*l.* 5*s.* 11*d.* This taken in connection with the statement of assets and liabilities shows the Association maintains its satisfactory financial position.

The Ballot lists having been duly issued the Scrutineers report the result of the voting as follows:—

President—J. Cartwright, of Bury.

Vice-Presidents—A. R Binnie, J. T. Eayrs, and T. Hewson.

Ordinary Members of Council—A. Brown, E. Buckham, J. Cooper, J. H. Cox, E. R. S. Escott, S. Harty, C. H. Lowe, J. B. M'Callum, S. S. Platt, O. C. Robson, T. Walker, C. F. Wike.

General Honorary Secretary—C. Jones.

Treasurer—Lewis Angell.

Since the last Report, two examinations have been carried out, the first of which was held in October 1891, at the Town Hall, Manchester, the use of which was kindly granted by the Corporation of that city. On this occasion six candidates were entered, four of whom satisfied the examiners, and were granted their certificates. The examiners were Messrs. Fowler, Jones, Lemon, and Pritchard. The second examination was held in April last, at the Institution of Civil Engineers by kind permission, when eighteen candidates were entered. Of these, eleven satisfied the examiners, and were granted their certificates. The examiners were Messrs. Dunscombe, Jones, Lemon, and Lobley. The next examination will be held at the Yorkshire College, Leeds, on September 30th and October 1st.

The Parliamentary Committee have again considered the various suggestions received from the Members of the Association with regard to the amendments to the Public Health Act, 1875, and the Acts incorporated therewith. No less than ninety-two proposed amendments have been thus received, which after much deliberation have been formulated by the Committee with reference to the sections of the Acts affected thereby, and which represent the following :—seventeen sections of the Public Health Act, 1875 ; one section of the Highways and Locomotives Amendment Act, 1878 ; and three sections of the Public Health Acts Amendment Act, 1890 ; total, twenty-one sections. Upon the recommendation of the Council, the amendments thus formulated were communicated in the first instance to the chairman of the Police and Sanitary Committee for his consideration. Such communication has been favourably acknowledged by him, but he regrets that the exigencies of Parliament then existing would prevent him rendering justice to the matter during that session, but that he hoped to have the opportunity of dealing with the same during the ensuing session of Parliament. It is also the intention of the Council to forward a copy of the proposed amendments to the Local Government Board, soliciting their consideration of same in any proposed amendments promulgated by that department. The Council hoped that the action thus taken may eventuate in many useful and beneficent amendments being introduced into the statutes now appertaining to Local Authorities, the necessities of which have been so long felt by officers of various local bodies, who are now engaged in the practical work embodied in present local legislation.

The subject of sewer ventilation, as represented by suggestions received thereon from various Members of the Association and others, having been referred to Mr. Gilbert Redgrave, a report has been received from him, and considered by the Council, with the result that they are of opinion the views expressed in the suggestions received are so conflicting and necessitate so great an expense in publication that they consider the result of publication would not be commensurate with the cost involved thereby. The report with the papers attached thereto has however been included in the papers deposited at the Offices of the Association, where they are open for the inspection of any of the Members of the Association.

The committee appointed to award the premiums for the two best papers read in the twelve months ending at the last Annual Meeting, have recommended that the first premium of 10*l.* be given to Mr. T. Walker, of Croydon, for his paper entitled "Some of the Public Works of Croydon," read at the District Meeting held there on July 19th, 1890, and the second premium of 5*l.* to Mr. Robert Godfrey, of King's Norton, for his paper entitled "Way-leaves and Easements," read at the Annual Meeting held in London in June 1891, and the Council have awarded these prizes accordingly. The Council desire to repeat that it is hoped the granting of these premiums will emulate members to improve the volume of Proceedings in making it a valuable book of reference on all technical matters relating to municipal engineering.

The Council deeming it necessary to oppose the application of the Sanitary Inspectors Association for Incorporation, presented a memorial to the Board of Trade opposing such application principally upon the ground that the Association seeking incorporation included in their Articles of Association powers to carry out examinations.

The Council have also presented a petition to the Privy Council in opposition to the application of the Sanitary Institute for a Royal Charter of Incorporation, with regard to the clauses relating to examinations, and granting certificates of competency to municipal and county engineers. Negotiations, however, are in progress which are likely to result in a satisfactory arrangement, in which case the opposition of this Association will be withdrawn.

The President moved, and Mr. Broom seconded, the adoption of the Council's Report. Carried unanimously.

The President then presented the premiums, the first to Mr. T. Walker, of Croydon, and the second to Mr. R. Godfrey, of King's Norton.

It having been moved and seconded, it was agreed that the various District Secretaries at present holding office shall hold office *pro tem.* and until such time as the districts shall meet and reappoint them or others in their place.

Messrs. R. Godfrey, G. E. Eachus, E. J. Silcock, and J. C. Radford were appointed Scrutineers for the ensuing year.

Messrs. J. Parker (Hereford) and A. Creer (York) were appointed Auditors for the ensuing year.

In the absence of Mr. Scoones, Mr. J. T. Eayrs moved and Mr. J. Lobley seconded the following Resolution:—

That in the view of the fact that the Association now numbers over 500 Members, the number of elected Members on the Council ought to be increased from 12 to 15, and this General Meeting begs respectfully to request the Council to take such steps as may be necessary to have the Articles of Association amended in order to carry out this Resolution.

Mr. C. Jones proposed as an amendment that the Resolution be referred to the Council for their consideration. This was seconded by Mr. Broom. Upon being put to the meeting the amendment was declared lost, and the votes of the meeting being in favour of the original resolution, it was declared carried.

Mr. Meade introduced his successor, Mr. J. Cartwright, who then took the chair.

Mr. Chas. Jones proposed and Mr. Eayrs seconded a hearty vote of thanks to Mr. Meade, the retiring President, for his valuable services to the Association during the past year.

Mr. Meade having returned thanks, the President then read his Inaugural Address.*

CHAS. JONES, *Hon. Sec.*
THOMAS COLE, *Secretary.*

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* This address, and the papers read at the Meeting, will be found at the end of this volume.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING APRIL 30TH, 1892. Cr.

RECEIPTS.	£	s.	d.
To Balance at Bank, May 1st, 1891	139	14	6
" Entrance Fees	100	16	0
" Subscriptions	380	12	6
" Subscriptions paid in advance	18	18	0
" Arrears	10	10	0
" Publishers' sale of 'Proceedings'	40	11	5
" Examination Fees	70	7	0
" Interest on Southampton Corporation Stock	10	4	8
" Balance of Petty Cash due to Secretary	4	6	6
	£776	0	7

EXPENDITURE.				£	s.	d.
By Report Cheltenham Meeting				30	9	0
" " Stourbridge "						
" " Hastings "						
" " Norwich "						
" " Annual "						
" " Dublin "						
" Expenses Annual Meeting, 1891				11	2	2
" Incorporation Expenses, Solicitors' account				49	4	10
" Irvine & Co. sundry Printing Circulars	£49	2	9			
" " " Postages	12	15	7	61	18	4
" Examiners' Expenses and Fees				48	12	3
" Auditors' Travelling Expenses				2	11	4
" Premiums				15	0	0
" Maclure & Co. engraving Certificate				10	16	6
" Sprague & Co. for Illustrations				3	8	6
" Messrs. Clowes, Printing Vol. XVII. including Postage				197	10	3
" S. Redgrave, Report on Sewer Ventilation				26	5	0
" Secretary's Salary				106	5	0
" Rent				30	0	0
" Travelling Expenses				12	8	10
" Honorarium to Secretary				26	5	0
" Bank charges				0	11	2
" Petty Cash—Postages	12	9	2			
" " General	21	17	4	34	6	6
" Balance at Bank, April 30, 1892				109	5	11
				£776	0	7

STATEMENT OF ASSETS AND LIABILITIES, APRIL 30TH, 1892.

LIABILITIES.	£	s.	d.
To Estimated Liability on Vol. XVIII.	40	0	0
" Sundry Printing	20	0	0
" Secretary, Balance of Petty Cash	4	6	6
" Balance	499	6	11
	£563	13	5

ASSETS.				£	s.	d.
By Balance at Bank				109	5	11
" £300 Southampton Corporation 3½ per cent. Stock				305	5	0
" Subscriptions in Arrear	63	0	0			
" " less 50 per cent. bad	31	10	0	31	10	0
" 'Proceedings' in Stock	175	5	0			
" " less 50 per cent.	87	12	6	87	12	6
" Office Furniture				30	0	0
				£563	13	5

Examined and found correct, } Auditors. CHAS. JONES, Hon. Sec.

DISTRICT MEETING AT DUBLIN.

September 25th and 26th, 1891.

Held at the City Hall, Cork Hill, Dublin.

MR. T. DE COURCY MEADE, PRESIDENT, *in the Chair.*

THE PRESIDENT, in opening the proceedings, said:—

Perhaps, as this is our first meeting in Ireland, it would be well if I should briefly call your attention to the objects for which this Association was formed. It was formed some twenty years ago, and three years ago it was incorporated, when the scope of the Association was extended considerably. County surveyors and other engineers who were not originally included in those eligible for membership were admitted, and now, I am pleased to say, the numbers have increased, and the interest felt in the work of the Association has extended, not only through Great Britain and Ireland, but also to many other countries; we have Members in India, in China, in America, and, indeed, I might say in all parts of the world. The Association was formed by a few municipal engineers, who felt the want of some such body which would give them an opportunity of meeting together and interchanging opinions, and discussing subjects of interest to municipal and county engineers. Now the municipal and county engineers have very important duties to perform in their respective districts. The municipal engineer, unlike the medical man, who tries to cure after the disease has broken out, strives to prevent those diseases to which we are so liable from bad sanitation, inferior water supply, and other troubles we have to contend with in our towns; and he has, I am pleased to say, so far succeeded during the last twenty or thirty years that the death-rate in England and Ireland has been greatly reduced. I recollect passing through Dublin for the first time twenty years ago, and then it was a city very different from what it is to-day. The pavements at that time were not of the best, and I was pleased to note that a great change had taken place when, ten or eleven years ago, I visited the city a second time. I was still more pleased when this week I saw the important improvements since carried out. The hurried visit we pay this time to Dublin will prevent Members who have not been here before from seeing one-tenth of what is to be seen in this ancient and interesting city, but I hope that this, our first visit to old Ireland, may be one of many happy and instructive ones which we may pay to this country.

The following papers were then read and discussed:—

SANITARY AND OTHER WORKS CARRIED OUT BY THE CORPORATION OF DUBLIN.

By SPENCER HARTY, City Engineer, Dublin.

It is difficult in a paper like this to give sufficient technical details to entirely satisfy the professional mind, as in such a case it would extend over so wide a field as perhaps would become wearisome.

The object in the writer's mind is to give the Association, on their visit to Ireland, as graphic an account as possible of the sanitary and other works carried out by the present Corporation of Dublin, who, with the limited means placed at their disposal, have within the last thirty years so much improved the city that it now can compare favourably with the best regulated cities in the British Empire. Unfortunately, Dublin is not a manufacturing city—and portions of the old city are going into decay; but yet, like the Phœnix, it seems to again rise out of its ashes, other portions springing up and taking the place of those going into decay. The valuation of the City was made many years ago, and the rates are still struck on this old valuation, which in most cases averages only from one-half to two-thirds of the rent of the houses, accordingly the rates seem high in proportion. The city is also surrounded by townships with independent control, and to a stranger it would be impossible to say where the city ends and the township begins; not one of these townships would be in existence but for the city, and they are dependent on the latter for their support. It is late in the day for such divisions now; all should be united and placed under one joint board of control and government, who would work together in harmony for the general good, and so equalise the rates.

There are other works carried out by the Corporation beside those here mentioned, but time does not allow a reference to all.

The author purposely refers back some centuries with regard to most of the works, in order to show that the people of five or six hundred years ago seemed to be alive to sanitary matters which in more recent times were entirely neglected, and if this branch of knowledge had progressed steadily from the more remote periods, we would be far in advance of our present position, and the Public Health Act of not quite twenty years ago would probably not have been required. The dark ages of European history seemingly have repeated themselves with regard to sanitary science and knowledge.

Dublin.

Ptolemy in the year 140 A.D. describes Dublin as famous. In the fifth century the Danes captured the city and inclosed it by walls. From this period to the eleventh century the history of the city proper possesses but little interest, the records being very meagre and confined mostly to accounts of the wars and combats between the native Irish and the Danes who from time to time invaded the country. Nevertheless there are remains of ancient buildings extant which can be attributed to a period anterior to the coming of the English. In the year 1171 King Henry II., on his arrival and assumption of the title of Lord of Ireland, granted by charter to "his men of Bristol, his City of Dublin to be held by them from him and his heirs with all liberties and free customs which they have at Bristol and throughout his entire land."

The first charter of importance, however, is that granted by Henry's son, Prince John, and by it, according to Mr. Gilbert, "the legal rights of members of the Dublin Municipality were for the first time defined in a series of sections analogous to those in the Royal Charters to London and important towns in England." This charter, subsequently ratified by King John on his accession to the Crown of England, "formed the basis for municipal legislation in Ireland." It defines the boundaries of the city, and its possessions both within and without the walls, and specifies in twenty-eight clauses the liberties and free customs granted to the citizens.

From this charter we gather that, to a large extent, there was then no individual or private ownership in the soil of at least a great portion of the city, for it states:—" Every Citizen may for his own advantage build wherever he wishes on the bank [of the river], but without damage to the City or Citizens " And further, " The Citizens may have and possess all lands and vacant places within the before-named boundaries for building upon as they may desire." And " all tenures within and without the walls, to the extent of the before-named boundaries, shall be disposed of according to their pleasure by the common consent of the Citizens in messuages and in plantings in buildings over the water and elsewhere in the City."

An early reference to the public works of the city is to be found in the Charter of Edward II. (1322), by which permission is given to the mayor, bailiffs and citizens, in aid of paving the city, to levy tolls on certain goods brought into the city for sale during the ensuing four years. This equivalent for the modern Improvement Rate was followed by other charters for a similar purpose; for instance, Edward III. in 1336 gives grant to mayor, bailiffs, and commonalty for ten years from termination of nine years " as yet unexpired from existing grant," to levy customs on certain goods brought to the city for sale, the monies thus received to be expended exclusively upon the Tholsel and the completion of the paving of the city. And further reference to the pavement works of the city is frequently made in succeeding charters.

The City of Dublin which we now have to deal with is of much larger dimensions than the Dublin referred to in the old charters, and is surrounded on all sides by townships with corporate control independent of the Municipal Corporation. The city proper is bounded by the Circular Road and Royal Canal on the north side, and Grand Canal on the south, and contains 3808 acres, the River Liffey dividing the city into two parts. The average breadth of the city from west to east is 3¼ miles, and length from north to south 2½ miles. It stands somewhat low—the level of the roads on the quays being on an average 20 feet over low water-mark, ordinary spring tides Dublin Bay; from thence there is a gradual rise to the north and south—the former standing on an average 90 feet over O.D., and the latter 65 O.D.

The local authority is the Corporation of Dublin, comprising the Right Hon. The Lord Mayor, Aldermen and Town Councillors (sixty members in all, fifteen aldermen and forty-five councillors), representing fifteen wards into which the city is divided. This, the reformed Corporation, came into being in 1851, superseding the older Corporation guilds and a commission known as the Paving Board.

The first great sanitary work of the present Corporation is the waterworks, and in dealing with this subject, as with others, the author trusts he will be pardoned for retrograding a little into past history.

WATERWORKS.

One of the earliest acts of the old Municipality was the conveyance of water to the city for the domestic use of the inhabitants, and in the selection of a source of supply much judgment was displayed. For over 600 years the water supply was taken from the Dodder, and even at the present day this water is availed of for extensive trade supplies.

The following entry in the 'Liber Albus,' or White Book, gives possibly the earliest reference to a water supply for the city, viz.:—

"Writ for Inquisition in relation to water supply for Dublin, 1244.

"Maurice Fitzgerald, justiciary of Ireland, commands the Sheriff of Dublin, without delay, by twelve free and lawful men of his county to make inquisition, with advice of the Mayor and Citizens, as to whence water can be best and most conveniently taken from its course, and conducted to the King's City of Dublin, for the benefit of the City, and at the cost of the Citizens who have undertaken to pay the amount. By the same twelve men the sheriff is to inquire whether any damage can arise by thus taking and bringing the water," &c.

Following the above, frequent entries respecting water supply are to be found in the records; donations to the maintenance of of the pipe are mentioned. Water grants to the Dominicans some time prior to the year 1255, are thus recorded:—

"The Mayor and Citizens grant to the Church of the Holy Saviour, near the Bridge of Dublin, and to the Friars Preachers serving God there, as perpetual alms, permission to receive part of the City water supply, to be taken within the walls of the City at the new gate near the house of William the Clerk, by there attaching their pipe to that of the Citizens. The Friars are to have liberty to lay their pipe through the land of the City, as far as their house, and across the river, but without damage to the Bridge. The diameter of the Friars' pipe is to be five inches; within their house it is to be so far narrowed that its opening may be stopped by the insertion of a man's little finger, and it shall at no time be larger. If the Friars enlarge the pipe without the consent of the Citizens this grant may be revoked. The Citizens undertake, without future cost or charge to the Friars, to sustain and mend the City conduit pipe, the Friars keeping their pipe at their own expense."

And further, in the year 1289, the Mayor and Commonalty grant to William le Deveneys a supply from their water conduit, by a pipe of the thickness of a goose quill, to be taken from the city pipe within the new gate, and to be brought at his cost to the stone house which belonged to William Picot.

The goose-quill supply seems to have been adopted as a sort of standard, for in 1287 mention is made of "a small supply of the city water, through a pipe of the diameter of a goose-quill," and this gauge for water pipes is frequently mentioned in the records.

The conveyance of water by leaden pipes was early known to the inhabitants of the city, for in the year 1448 it is ordered that "the twelve pence payable by each person admitted to the franchise of the City shall be received by the treasurer towards the leaden pipes of the City"; and in 1558, in the stock list of the City, is included "a great draught tree to cast pipes of lead 7*s*."; and later, in the year 1559, we find the following order was made:—

"Whereas complaint is made by the inhabitants of St. Thomas Street, and St. James Street, of the decay of the pipes leading through their back sides to the conduits of this City: for remedy whereof, it is ordered by the Authority aforesaid, that Mr. Mayor and such as are appointed to survey the works of Newgate, and other needful works, shall take consideration of the pipes presently, and thereupon Mr. Mayor to appoint some honest Citizen that first goeth into England to provide both a good plumber, and such store of sheet lead as shall be in their good discretions thought meet, and what the charge of the lead shall be, or the hire of the plumber, the same being laid down by Mr. Mayor and the rest now appointed to view the works, that shall be holden as good, and to be borne by the City by authority of this Assembly."

Wooden troughs or shoots were also in use, for among several entries relating to the maintenance of the waterways, and the protection of them from contamination, it is noted (Assembly 1587) that Patrick Crosbe, of "Dublin, carpenter, shall have the oversight and keeping of the course of the water of the pipes of the City from Dolphin's Barn to the cistern, with the grass and other commodity belonging to the same, the said Patrick repairing the trough of timber, the City finding stuff."

In connection with the water supply, it may be mentioned that entries are also to be found in the records of the measures adopted for the protection of the city against fire. In 1546, the Assembly agreed "that 12 graps of iron shall be made for pulling down of houses that shall chance to be afire, 40 buckets of leather for carrying of water, and these to be provided by masters of the works, by the oversight of Master Mayor with all speed."

The roll of 1592 contains a further entry on this subject:—"Forasmuch as . . bringeth to . . this city to . . loss might ensue if danger of fire, from which the Lord deliver us . . . by occasion that store of 'fyrr and fagot' ricks are permitted to stand in several places of danger, as well in this City as in the suburbs, contrary to the laws of this city, for remedy, thereof it is agreed by the authority aforesaid, that Mr. Sheriffs shall presently put the laws touching 'fyrr reekes' in execution, and withall it is agreed that Mr. Mayor shall see the water brought, and also that every parish shall provide and make, upon their charges, six buckets, and two ladders of the length of 30 rungs a piece, and that the same buckets and ladders be kept in the several parish churches, to be preserved and kept by the church wardens, and to be continued from time to time, as need shall require; and if this be not executed and put in due execution by the sheriffs for the time being, then they to pay the fine of 5*l.* to the treasury of this city for every rick of furze by them suffered to continue within the City."

From time to time the supply of water was found most inadequate, and various alterations and additions were made until in 1806 contracts were entered into with the two canal companies for a supply of water to the city; this was accordingly taken from basins situated as follows:—Basin Lane, off James's Street, the top water being 75 O.D., the area of the basin being 3 acres 2 roods 14 perches; Stainer Street, containing 2 acres and 8 perches, and level of water, 76 O.D.; and afterwards Blessington Street, containing 1 acre 3 roods 3 perches, and level of water 78 O.D.

It will easily be perceived that this state of things could not continue, as several of the streets could not by any means be supplied, and most of the others had to be supplied on the intermittent system. The rate paid to the canal companies for this water was a total of 2500*l.*, the scale of charges which the public had to pay being—

	£	*s.*	*d.*
For houses valued under 5*l.* per annum, no charge.			
„ „ at 5*l.* and under 10*l.* per annum ..	0	5	0
„ „ 10*l.* „ 20*l.* „ ..	0	10	0
„ „ 20*l.* „ 50*l.* „ ..	0	15	0
„ „ 50*l.* „ 80*l.* „ ..	1	7	6
„ „ 80*l.* and upwards „ ..	1	10	0

An extra charge was made of 9*s.* 2½*d.* per annum for each w.c. supplied, and 20*s.* for each stable. These charges were undoubtedly unfair, as a house valued at say 50*l.* had to pay 1*l.* 7*s.* 6*d.*, while the one adjoining, valued at 49*l.* 19*s.*, paid but 15*s.* per annum. Accordingly, in 1851, the question of a better supply of water to the city began to be agitated by the present Corporation, and several reports and suggestions made—the outcome being the Act obtained in 1861, after one of the most bitter fights ever fought before a Committee of the House of Commons, the success being due to the indomitable pluck of the late chairman, Sir John Gray, who, by persistent and determined energy and cool courage, overcame all opposition, which at the time poured in on all sides, not only from the wealthy citizens of the day, but also from the most learned, who wrote pamphlets against the Vartry supply, and the quantity of water which could be derived from that source, as well as railing at the cost.

The author will now proceed to give a brief description of the water supply to the City of Dublin, the originating of the site being due to Mr. Richard Hassard, a Dublin engineer at present residing in London, but the works were carried out by the late City Engineer, Mr. Neville, with whom the author as well as others were assistants.

The Vartry stream rises at the base of the Sugarloaf Mountain (on its southern side), in the County of Wicklow, at an altitude of about 1050 over Ordnance datum, and flows from north to south a distance of five miles to the commencement of the impounding reservoir, situate under the village of Roundwood, passing altogether through pastoral lands. On its route to the reservoir it receives the addition of tributaries, some of which are larger than the main stream itself. The geological formation of the ground is the Cambrian and Lower Silurian.

The water is pure soft water, very much akin to that of Lough Katrine, the degree of hardness being about 1·600 before boiling—Lough Katrine being about 1·900. A recent chemical analysis by our Medical Officer of Health, Sir Charles Cameron, gives the following result:—

An Imperial gallon (70,000 grains) contained:—

Total solid matters	4·220 grains.
Including :—Albuminoid ammonia	0·006 grain.
Free ammonia	0·001 „
Nitrogen in nitrates and nitrites	Trace.
Phosphoric acid	Faint trace.
Chlorine	0·995 grain.

Oxygen absorbed from permanganate of potassium solution—

After fifteen minutes at 80° F.	0·058 grain.
After four hours	0·159 grain.

The colour of the water, when looked at in a tube two feet long, was clear, slight yellow: no smell. When water was heated, it exhaled no odour.

Dr. McWeeney, one of the most rising and talented members of his profession in Ireland, and an eminent bacteriologist, made an examination of our water supply this summer from a bacteriological standpoint, and arrived at the following results:—

1. That the number of germs in unfiltered Vartry water averages 5000 per c.c.

2. That the number of germs in water filtered through a lately cleansed filter bed, averages 80 to 100 per c.c. (that is, the filter cleansed right down to the bottom).

3. That the number of germs in water filtered through an uncleansed filter-bed varies within wide limits: generally more are present than in the unfiltered water; sometimes they may be so numerous as 12,000 per c.c. (this refers to filters from which only the surface sand has been taken and cleaned and renewed).

4. That filtered water kept free from atmospheric or other sources of contamination for three weeks always proves to contain a smaller number of germs than unfiltered water similarly preserved; and this result holds good whether the filter-bed through which the water has passed has been recently cleansed or not.

5. The explanation of (4) is, probably, that the process of filtration removes from the water a quantity of dead organic matter in

suspension—matter upon which bacterial life is known to be supported.

6. From the bacteriological standpoint the water delivered from the Dublin domestic supply taps is extremely pure. The living germs do not average more than from 20 to 50 per c.c.

7. The falling off in the number of germs between Callow Hill and the City is very striking, and may be ascribed to any or all of the following causes acting together or separately—

a. Absence of atmospheric oxygen in the pipes.
b. High pressure in pipes.
c. A sedimentation process going on at Stillorgan.
d. Injurious action on the germs of the slimy iron oxide deposit on interior of pipes.

8. The organisms found hitherto in Vartry water belong to 23 different species, of which the following have been identified, amongst others :—

Gasbildender Bacillus (Eisenberg).
Verflüssigender „ „
Bacillus mycoïdes (Zimmermann).
„ *ochraceus* „
„ *punctatus* „
„ *fluorescens tenuis* (Zimmermann).
„ „ *liquefaciens* (Zimmermann and Flügge).
„ *viscosus* (Frankland).
„ *implexus* (Zimmermann).
Proteus vulgaris (Hauser).
Micrococcus cremoïdes (Zimmermann).
Saccharomyces rosaceus.
Typhusähnlicher Bacillus (Weichselbaum).
Bacillus mesentericus vulgaris (Flügge).

None of the above species is capable, under ordinary circumstances, of producing disease. The author is not aware of any water in the United Kingdom having been examined by a bacteriologist as the Vartry; and undoubtedly this system will become more and more general, and be of great use to engineers.

The falling off of the number of germs between Callowhill and the City is most remarkable, and the author considers that it is principally due to the high pressure and velocity of the water in the pipes.

The difference also in the number of germs in the unfiltered water and in the water coming off a filter-bed which has been recently thoroughly cleansed, speaks for the advantage of this work, and to which reference is made further on.

The works commenced in the year 1862, by forming a large embankment to impound the river and flood the lands to a level of 692·50 over datum, the top bank being 698·50. The area of the ground under water is 409 acres, the by-wash or overflow weir 300 feet long; the cubical contents of water in the reservoir at this level is 2,374,358,344 gallons, but means have since been adopted to raise the height of water 12 inches, by stop planks fixed on the top of weir, which has the effect of increasing this quantity by nearly 109 million gallons.

A tunnel is built in the rock under the embankment, having a solid plugging (on the water face) of Staffordshire blue firebrick set in cement, 38 feet thick; through this are carried two main pipes, the one being 33 inches diameter for the supply, and the other 48 inches for purposes of running water into old bed of river below the works in case of any necessity to do so.

The water can be taken into this 33-inch main from different levels in the reservoir, according as it rises or falls, so as to enable it to be brought on to the filters as pure as possible (inlets being fixed at 683·03, 672·80, and 662·60), and from thence it passes on through feeders or goits on to the filter-beds, now ten in number, which are constructed in the usual manner, having 6 feet 6 inches of filtering material, composed of sand, gravel, and broken stones; the system adopted being downward filtration. The area of the water on the filters is about 24,480 square yards for the entire number, which will easily filter, according to usual formula, about 17¼ million gallons per day.

Until last year, in maintaining and keeping the filters clean, the usual custom was to scrape off the top layer of dirty sand from each filter as it required attention, and then turn on the water again, this process being continued until the sand was worn out, and the filter required a complete renewing of fresh sand.

This scraping off of the dirty sand from the filter requires only about two days for eight men. The filters in winter are each able to work from 5 to 8 weeks, and in a dry summer, if the water gets very low in the reservoir, for about 4 weeks, without requiring any attention or cleaning, the head of water varying accordingly from 2 to 3 feet.

On an average, from 150 to 200 tons new sand is used each year in the ordinary course of cleaning, so that a similar quantity must be lost in the washing and from other causes. The cost of cleaning out 3 feet of sand on top, washing and restoring, labour and material, is about 66*l.*

Last year, for the first time since the works were completed, the author commenced to have the filters entirely cleaned down, including the dry rubble drains in the bottom; the materials thoroughly washed, and sides concreted. This is a troublesome and expensive process, but it is well worth so doing, as the water comes off the filters thus treated infinitely purer than from those treated in the former manner; they also filter more rapidly than before, and the three now done are able to make up for an additional filter working short (as the two processes are going on), without having to increase the head of water on any of the other filters.

It took 15 men 18 weeks to clean out and entirely renew one of these filters, at a cost of about 208*l.*, including horse hire, &c.

When all are complete, the work will really prove a saving, and the filtration being more rapid the filters will do more work; as well as doing it better than before. Taking the quantity of filtered water passing over Callowhill Weir as 14,000,000 gallons per day, the cost of "labour" for maintenance at impounding reservoir, and for filtering, is equal to about $\frac{1}{10}$*d.* per 1000 gallons.

The average rainfall over the catchment area (which is 14,080 acres) for each year since 1861 has been as follows, the rain gauges being situated at altitudes varying from 720 to 1000 over datum:—

	Inches		Inches.		Inches.
1861 ..	60·86	1871 ..	51·65	1881 ..	51·40
1862 ..	60·65	1872 ..	69·34	1882 ..	61·03
1863 ..	45·09	1873 ..	40·08	1883 ..	57·15
1864 ..	47·76	1874 ..	42·50	1884 ..	39·16
1865 ..	48·69	1875 ..	61·76	1885 ..	47·82
1866 ..	53·43	1876 ..	65·50	1886 ..	49·91
1867 ..	46·05	1877 ..	62·08	1887 ..	31·91
1868 ..	56·15	1878 ..	48·51	1888 ..	60·13
1869 ..	49·00	1879 ..	55·14	1889 ..	47·34
1870 ..	43·68	1880 ..	56·77	1890 ..	47·02

1887 being the driest year since our works commenced.

From the filters the water passes on to two pure water tanks (both filters and pure water tanks are uncovered), from whence it is conveyed through an iron pipe 820 yards long joined to a tunnel 6 feet by 5 feet (egg-shaped), 4332 yards long, having a fall of 4 feet per mile; the water emerges from this tunnel at Callowhill, where it flows over two 10-feet weirs into a circular basin 86 feet in diameter and 10 feet deep; the level of the water in tank is 602. From this point it is carried by a single line of 33-inch diameter pipes, having a hydraulic gradient of 20 feet per mile, to the service reservoirs in Stillorgan (three in number). Between Callowhill and Stillorgan there are three relief tanks, where the pressure is broken: these tanks are—

Kilmurry	473	feet over datum.
Kilcrony	414	,, ,,
Rathmichael ..	341	,, ,,

The top water in the service reservoir at Stillorgan stands at 271 and 274 feet respectively for the upper and lower reservoirs, and the Gray Reservoir when full at 274, the total contents being as nearly as possible 166,000,000 gallons.

When the works were first started, as much as 20,000,000 gallons per day were sent down over the Callowhill Weir—now the quantity which the pipes will take is much less: this is due to oxidation in the pipes, the soft water acting on the cast iron creating a number of nodules of oxide of iron on the interior, which not only have decreased the delivering capacity of the pipes, but have also seriously increased the friction. A proposition is now before the Corporation to lay a second line of main from Callowhill, so as to maintain a proper supply of water to the various districts. From Stillorgan the water is brought into the city in two 27-inch diameter pipes, connected at intervals on the route, so that a section can temporarily be shut off for repairs and one main feed the two. At the City boundary (Leeson St. Bridge) a pressure-gauge station is placed, where the pressure on the mains, both on the city and county side of valve is hourly recorded day and night; from this point the mains bifurcate, the one continuing on in a northerly direction, the other going eastwards and northwards, until both meet again at the extreme of the northern side of the city, thus creating a ring, and forming a main artery from which all other mains and services are fed, and which are again all joined into each other with valves on each end of every street, so that supplies can be taken from any point, and perfect circulation secured. Bateman and Moore pattern ball hydrants are fixed on the kerb of footpath at regular intervals of 100 yards. All the large mains are lead joints, but from and including 18 inches and downwards they are turned and bored, the taper being 1 in 32.

These joints have practically never given any trouble, the 18-inch especially, not one of which ever leaked.

The supply of Vartry water extends and ramifies over a very extended area and district which includes :—

The City	3808 acres
Clontarf Township	1295 ,,
Drumcondra Township	918 ,,
Kilmainham ,,	535 ,,
Pembroke ,,	1621 ,,
Blackrock ,,	1084 ,,
Kingstown ,,	1467 ,,
Dalkey ,,	592 ,,
Killiney and Ballybrack Townships	1017 ,,
Bray Township	1070 ,,

and to extra-municipal and rural districts, comprising :—Cabra, Phœnix Park, Artane, Yellow Lanes, Terenure, Dundrum, Rathfarnham, Rathdrum, &c., of which it is impossible to get the exact area and population.

The entire district supplied, including city, townships, and extra-municipal districts, contains an average area of about 40 square miles, all of which is supplied with water from the 33-inch main under the main embankment at Roundwood, only 3¾ turns of the valve being open out of a total of 40 turns, the full number which it takes to open the valve.

Each township pays the Corporation a certain fixed rate on its valuation for the water supply, but the supply to the rural districts is in the hands of the Corporation.

The entire cost of the works has been 660,000*l.*, which is equal to about 1*l.* 17*s.* per head on the gross population supplied, taking the population of rural districts at 20,000.

The charge for water for domestic purposes to the inhabitants in the city is a rate of 4*d.* in the £, and 3*d.* for public water rate, making a total of 7*d.* in the £ on the Government valuation.

Water for trade purposes is charged at the rate of 6*d.* per 1000 gallons, and for small supplies which it is difficult to measure separately from the domestic, a charge of 20*s.* per annum is made.

It is impossible to get even approximately at the domestic consumption per head of the city population, as the trade supplies are so interwoven and mixed up, and there are no means of measuring water at the city boundary; but the supplies to the various townships for the past year are given here as measured. Practically there are no manufactories in any of the townships, but there are trade supplies.

———	Population per census of 1881.	Average daily supply.	Rate per head.
			gallons.
Clontarf	4,210	231,553	55
Kilmainham	5,739	107,134	18⅗
Pembroke	25,014	784,803	31⅓
Blackrock	8,902	289,455	32½
Kingstown	20,346	656,717	32¼
Dalkey	3,234	159,876	49⅓
Killiney	2,607	54,499	21
Bray	6,535	396,926	60⅔

Three of the foregoing are out of all proportion in their consumption to what they should be.

The rental received by the Corporation for their water supply for 1889 from all sources was, gross total, 62,343*l.* 13*s.* 11*d.* The cost of maintenance, including salaries of officers, office expenses, labour and materials, was 60,491*l.* 6*s.* 4*d.* Leaving a balance to credit of 1852*l.* 7*s.* 7*d.* on 31st December, 1889.

Particular attention is given to the prevention of waste water, the system adopted being the day and night inspections, as adopted in all well regulated water systems, but no waste water meter is used; and from the time the Vartry water was first taken into Dublin until the present day not a single valve had to be shut down or lowered, in order to check any supply, or to put the houses on short or intermittent water.

The Corporation are rated for the waterworks and mains, and for the entire system of distribution through the city and extra municipal districts. This seems rather a hardship, as a Corporation is not a company working for profit, but simply are the representatives of the citizens who are parties agreeing to tax themselves for sanitary purposes and improvements; and so far as these works are concerned, any surplus on the maintenance had to go to the payment of principal and interest on the various loans, which of late years was becoming rather serious, and but for the recent conversion of the Corporation loans into stock (a work eminently due to our Town Clerk, Mr. John Beveridge, Barrister-at-Law, and Mr. Thomas Sexton, M.P., one of the Town Council), the water rate would require to be increased in place of being reduced as it now is.

Before closing this portion of his paper, there are two or three things which the author has personally learned during the construction of the works, the calling of attention to which may be of use to some engineers engaged in either designing or maintaining waterworks, but especially to the junior members of the profession. The remarks may be commonplace, but very often commonplace things, though most useful, are those least regarded.

Never have a vertical joint in puddle; in order to be of any service it must always have a seating; we had a serious and most expensive leakage arising from the neglect of this most simple precaution on a portion of our works, although we had most eminent men as consulting engineers.

At stated intervals clean your filters down to the bottom, sides and all, including either rubble drain or perforated pipes—especially if the water is at all peaty (see results of Dr. McWeeney's tests). Filters should be made at the service reservoirs, and water after filtration never allowed to see the light until it is delivered in the houses.

In carrying pipes through banks, make sure that they are carried entirely under the seat of the bank, and that they are arched over, either in a culvert or otherwise, as they are then relieved from the pressure of the subsiding bank on top, and so free from danger, and can also be got at for repairs if necessary.

Never allow a portion of a pipe to rest on rock or masonry whilst another portion is on clay, as if so it is sure to be broken across.

All air valves on large mains ought to have screw valves fixed between them and the mains, as in many cases of charging mains, where from either the air ball sticking in the bottom or from some other cause it did not act, and consequently water had to be again shut off, until the ball was set right; also if a main is working and repairs required to air valve, the water must be shut off a long section of main—always a dangerous and troublesome operation, both as regards shutting off water from mains under heavy pressure and recharging—whereas if there was a screw valve between the main and air valve there need be no trouble. A long length of main with but little rise or fall eminently requires the precaution of air valves, as air lodges in such a main.

A curious fact has also been noticed. During a severe winter some years ago, and whilst there was a heavy fall of snow, it was found that where our mains crossed outside the canal bridge at Leeson Street, and were fully exposed without any protection, the snow did not remain on them; taking up a handful of it and throwing it on the pipes, it immediately melted, showing that the friction of the water caused a certain amount of heat in the pipes.

PAVING.

About the year 1613 we learn from the City ordnances that the public works were carried out by a general muster of the citizens. They say:—"In the four quarters of the City, on Wednesdays and Thursdays weekly, after dinner, one man at least shall come from each house on public works. Meanwhile all the shops to be closed, and those who during that time sell goods contrary to this order to be fined, and the amount applied to the public works of the City."

The manner in which these works were carried out under so strange and arbitrary an order is not recorded, but it would be of some interest to know how the citizens mutually arranged to fulfil their obligations under the following decree of the year 1573. "It is agreed also, that the inhabitants of Thomas Street shall pave the street before their houses and ground that they occupy, until the same do come unto the channel, where the water run, or until the same do come unto the great pavement lying betwixt both the channels; and as for that great pavement, the inhabitants next adjoining unto the same, finding only sand and gravel to serve the paving the City, shall stand to and be at the residue of the charges of the said great pavement."

A special tax was imposed in the year 1480 upon the owners of iron-bound carts.

"*Item.*—It is ordained by authority of the Assembly that all such persons as hath iron-bound carts going upon the pavements of the City of Dublin, whether he be a denizen or a foreigner, that he and every of them shall pay yearly 2*s.* and 2*d.*, the said 2*s.* to be employed upon the works of the said City, and the said 2*d.* to the keepers of the gates."

The iron-bound carts in this order, it is presumed, refers to the wheels of the carts being shod with iron tyres, as undoubtedly at that period the usual cart wheel was cut out of a solid piece of wood, and without any tyre. If municipalities now could levy a tax on such iron-bound carts, what a revenue it would bring in for the maintenance of the streets! There is, however, a tax levied by the Goverment for hackney carriages, cars, and omnibuses plying for hire, but the proceeds go to the maintenance of the police. In more recent years, and up to the year 1851, the maintenance of the streets in Dublin was carried out by a Board called the Commissioners for Paving the Streets of Dublin, after which time it was transferred to the present Corporation, who lost no time in trying to set their house in order, and at once commenced to pave some of the streets with square setts, and laid down others with macadam; gradually, however, macadam is disappearing from the streets, and sett paving on a concrete foundation increasing in the same ratio. Before the passing of the Irish Public Health Act of 1878, the Improvement Rate in Dublin was limited to 2*s.* in the pound, so that the hands of the Corporation were practically tied, and very little improvement could be carried out in the way of street paving, &c. Previous to 1880 there was no street paved with setts on a concrete foundation; in this year, however, 100,000*l.* was borrowed from the Government for 20 years, at 7*l.* 0*s.* 8*d.* per cent., including principal and interest, the latter being 3½ per cent., and the first street thus paved was Marlborough Street.

The contract for this work was taken for the north side at 13*s.* 7½*d.* per yard, and on south side 13*s.* 3*d.*, the contractor being at liberty to screen and use any of the old macadam considered sufficiently clean and good for the purpose of the concrete, which was composed of 8 parts of broken stone and gravel to 1 part of Portland cement, laid 6 inches deep; on this was laid a cushion of one inch of sand, after which came the setts, 5 to 8 inches long by 3 to 3½ inches in width and 6½ to 7 inches deep, joints ¾ inch wide, filled in with clean gravel, and afterwards run with a grouting of pitch, tar, and oil; the mastic was then composed of one ton of pitch to from 30 to 40 gallons of oil, and 60 gallons of coal tar; but what is now used is simply pitch and oil, the cost of labour and material for this purpose for 940 yards in a street recently paved being as follows:—

	£	*s.*	*d.*
Wages	3	9	0
Pitch, 15 tons at 38*s.*	28	10	0
Oil, 620 gallons at 3½*d.*	9	0	0
Coke, 3 chaldrons at 12*s.* 6*d.*	1	17	6
	42	16	6

Equals 11*d.* per square yard.

The camber for cross-section of street was $\frac{3}{4}$ inch to the yard.

Again in 1886 another 100,000*l.* was borrowed, and paving still further extended on the same system, but work is carried out by men in the employment, and without any contractor; the cost of this work varies considerably, sone streets costing as much 13*s.* 6*d.* per yard, whilst others have cost only 11*s.* 6*d.*, the price of setts being much higher than formerly; the cross-section has also been reduced, but in many instances it would have been better if the streets had not been paved so flat, as the cost of maintenance is increased, and the water is not so easily thrown off. The entire cost of square sett paving in Dublin up to the present has been about 310,000*l.*

The setts formerly used were diorite granite from Penmaenmawr and syenite granite from Carnarvon, undoubtedly a first class paving stone, but it wears exceedingly slippery. Recently setts have been got from Ballintoy and Newry in the north, and from Arklow in the County Wicklow, the latter proving a good stone and not so slippery as the Welsh.

Welsh setts which have been in use in streets of considerable traffic, have been taken up after about 35 years, and have shown no very appreciable wear; indeed, a good many have been used again.

The total mileage of the streets and lanes of Dublin is about 126 miles.

For the maintenance of the streets the sum passed by the Council for this year is:

	£	*s.*	*d.*
Macadamising	6000	0	0
Paving	7491	0	0
Flagging	3425	0	0
Asphalting	500	0	0
Concreting for paths	2442	0	0

Now there are about 1,167,000 square yards of macadamised streets in the city, for maintenance of which we get 6000*l.*, or about 1¼*d.* per square yard of street surface, including labour; and where some of the streets are completely worn down and have to be remade each year, thus taking a large portion of the sum passed, it can hardly be said that the amount is sufficient for the proper maintenance of macadam in Dublin.* For the paving we get about $2\frac{1}{8}$*d.* per square yard, and for this also we have gradually to repave some of the streets, and still maintain and repair the wear and tear of the remainder, for which the sum voted is only $\frac{7}{8}$*d.* per yard. Most of the streets about the centre parts of the city, especially adjoining the river, are all on made ground (and in no parts have we a clean gravelly sub-soil), the consequence is that the sub-strata formation of the streets generally is a soft, muddy, and dirty one, and it is an absolute necessity, in a sanitary view, to use concrete foundation, and in many instances it should be thicker than the prescribed six inches.

The rate of wages in Dublin is as follows :—

Paviors, 6*s.* per day.
Men mixing pitch and oil, 5*s.*; assistants, 3*s.* 4*d.* per day.
Labourers, 3*s.* to 3*s.* 4*d.* per day.
Stone cutters, 5*s.* 6*d.* per day.
Drivers, 3*s.* per day.
Rammermen, 4*s.* per day.

Wood Paving.

Wood paving on concrete foundation was first laid down in 1880, the wood then used being red deal creosoted. Most of this work still remains intact and without requiring any outlay whatever, though laid about $11\frac{1}{2}$ years. Since then we have laid streets with beech, elm, fir, and Memel, none of the first three have given anything like the wear of the red deal (Archangel).

The average life of the beech in Dublin has been found to be between four and five years, fir between three and four years—the result being that their use is now discontinued. The elm is not giving satisfactory wear, showing great signs of wear after four years; one street was laid in 1887 without any concrete foundation, and the wood (underneath side) is commencing to rot rapidly.

SCAVENGING.

The ancient records contain frequent reference to the scavenging of the city, but do not describe the manner in which it was carried out. We learn that in 1489 a writ was issued to "Mayor and Bailiffs of Dublin, from Gerald, Earl of Kildare, Deputy to Jaspar, Duke of Bedford, Lieutenant of Ireland for Henry VII. The King has been informed that dung heaps, swine, hog-sties, and other nuisances in the streets, lanes, and suburbs of Dublin, infect the air and produce mortality, fevers, and pestilence throughout that city. Many Citizens and Sojourners have thus died in Dublin. The fear of pestilence prevents the coming thither of lords, ecclesiastics, and lawyers. Great detriments thence arise to his Majesty, as well as dangers to his subjects and impediments to business. The King commands the Mayor and Bailiffs to cause forthwith the removal of all swine, and to have the streets and lanes freed from ordure, so as to prevent loss of life from pestilential exhalations."

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* Last year 1800*l.* was spent in reforming three macadamised streets containing 15,000 square yards; if this sum was deducted from the 6000*l.* (the estimate) it would be $\frac{3}{4}$*d.* per yard to maintain the remaining portion.

Even as early as the year 1370 the keeping of swine within the city was prohibited, and orders like the following were made, expressly forbidding the keeping of swine within the city. "1491. It is ordained in the said Assembly holden the fourth Friday next after the feast of St. Michael the Archangel, the year of the reign of King Henry the 7th the 7th year, that all those that have swine within the walls of the said City, that they and every of them bring not the said kine nor swine within the said walls hereafter upon pain of forfeiture of them and every of them."

By the ancient ordnances it was decreed that "every householder must cleanse the portion of the street before his own door, under penalty of 12*d*." And later, in the year 1467, there is an entry on the rolls, "that whereas it is ordained by a law of the City [which] commandeth that [every man] should clean before his 'forestrete' on a pain be extended as well to 'forestrete' of gardens as houses within the walls, and that it be lawful to the Mayor for the time being to attach them by their bodies and put them on 'Warde,' and there to hold them till they make a fine notwithstanding their freedom." And in 1543 we find a general levy for the scavenging of the city, namely: "It is agreed as concerning the cleaning of the City, that every house within the walls having a stable shall pay every quarter 7*d*., and every house without a stable every quarter 2*d*., and every cellar and shop [within] the walls 2*d*. a quarter. And the same money to be levied by the constables of every ward, when they be thereunto required by Master Mayor and Bailiffs for the time being."

In 1546 the Assembly ordered that "there shall be another cart appointed for the cleaning of the City, and two assessors assigned in every ward for to tax the wages of the said cart." And the appointment of a Town Carter is thus recorded in the year 1598, "that Walter Sedgrave, Yeoman, shall have the office of town carter during his good behavior, so as he do take care of the cleaning of the streets and lanes DAILY according an ancient law taken in that behalf, or otherwise, that it be lawful for every alderman in his ward to punish him and his people, and withall, that he shall give the Mayor for the time being yearly 30 pecks of corn, market measure, videlicet, fifteen pecks fair wheat, and fifteen pecks dredge malt."

The entire scavenging and cleansing of the city is now carried out by the Corporation staff, and without any contractors ; stabling and offices, together with depots, being placed in various districts of the city. Strictly speaking, there are no refuse destructors in Dublin. We have in one depot a furnace for the burning of a certain description of garbage, but it is not of the most recent design such as are at present made in England. A great deal of the scavenge of Dublin has to be taken to sea in a hopper barge, which has to be towed out to sea by a tug boat some distance beyond Howth Head. There were 147 trips run last year, and 63,416 loads of unsaleable refuse were thrown into deep sea, the total cost being 1371*l.*, or a little under 5*d.* per load. Saleable stuff from the streets is as far as possible sold, but of recent years the sum received has dwindled down from 1400*l.* in 1888, to 662*l.* in 1890. Undoubtedly the time is fast approaching when proper destructors must be erected in Dublin, or else more barges put on the station, which is a most expensive operation. The cost of the barge was 6261*l.*

There were 474 men employed in the cleansing department last year, and 115 horses, the total cost of each horse amounting to about 10*s.* 6*d.* per week for food and straw.

The estimate for public and domestic scavenging for 1890 was 29,170*l.*—equal to 6*d.* per square yard on the entire surface of streets. The author is not able to give separately the cost of scavenge taken from macadam and paved streets.

SEWERS AND DRAINAGE.

There are something close on 100 miles of sewers in Dublin, 76 of which have been entirely newly built by the present Corporation, the remainder being old ones re-modelled, renewed, and underpinned; all the new brick sewers are egg-shaped, and the old have been newly inverted.

The sewage at present all gravitates to the Liffey, where it is discharged, all the outlets being well within the city boundary.

Although most of the sewers have good falls and are properly constructed so as to be self-cleansing, in a great many instances it is found that such is not the case—partly caused by the scavenging labourers sweeping the mud, &c., down into the gullies, and private drains being made use of for the purpose of getting rid of ashes and all sorts of house refuse. This is a difficult matter to deal with, as it is almost impossible in either case to get at the delinquents, nevertheless it is not only a source of trouble and annoyance but also of expense. There is no automatic flushing to any of the Dublin sewers, the course adopted being to flush periodically by means of a hose worked from one of the street hydrants.

For many years the question of taking the sewage out of the river has been agitating the public mind, and in 1870 a scheme was promoted before Parliament, and for which an Act was passed, to convey the sewage out to the North Bull, a distance of about 4 miles from the City boundary, and there discharge it into the bay at certain states of the tide. Plans were got up for this work and estimates obtained, but the amounts were so much in advance of the estimates that the work was withdrawn, and the scheme remodelled; but even this latter was withdrawn. Subsequently it was proposed to get up a scheme of precipitation, the works to be constructed on the slob lands at Annesley Bridge, immediately adjoining the City boundary; however nothing has been done, and the Act has been allowed to lapse.

The question has now again been brought forward, and the Corporation are at present deliberating on what course to pursue. Undoubtedly, so far as Dublin is concerned, that proper course would be to discharge the sewage at once into deep sea, if a suitable outfall could be obtained at a comparatively reasonable outlay.

Sewage is essentially a nuisance, and as such should be got rid of in the most expeditious manner possible; if this outfall cannot be obtained, and within reasonable limits as to cost, then the Corporation must fall back on precipitation, but this latter will be troublesome so far as the sludge is concerned, as Dublin farmers are not likely to trouble themselves much about taking it.

The question then will arise as to how to dispose of it, and must another barge be built to remove compressed sludge cakes by dropping them into the sea? As for making a profit (as some say) out of sewage treated chemically and otherwise, it is more an object to be desired than as yet accomplished.

The author regrets at a meeting like this that he is unable to go more fully into this subject, as it is still "sub judice."

In connection with the sewers however is the drainage of houses, without proper attention to which a city cannot be healthy; unfortunately, this matter has heretofore been most negligently attended to, and in order to provide a remedy in future, clauses were inserted in our Act of last year providing that where any dwelling house is drained only by a built or brick drain, the house shall be deemed to be without a drain sufficient for effectual drainage within the meaning of the Public Health Act. Power of entry has been obtained to test for escape of sewer gas and other defects.

Under a penalty of 20*l*., no new house after being built can be occupied unless nor until the City Surveyor has certified its fitness, and under a similar penalty no new house can be occupied in a new street until the part in which such house is built shall have been properly paved, sewered, and lighted, &c. These sections are moves in the right direction. Since the Act was passed (now just twelve months), several applications have been made by occupiers to test the drains as to proper construction, and in no case have they been found in anything approaching to good order; the result being that notices have to be served, and orders obtained to put the drains into a proper state.

Difficulty is found in enforcing the Act in regard to a certain class of builders in the City, as naturally they evade, if possible, having the drains thoroughly overhauled and tested, which they must be before any certificate is issued.

Ultimately this procedure of constantly testing drains and compelling proper house sanitation must have a very marked effect in lessening certain diseases, especially those of an enteric type.

In connection with the drainage of houses, plumbers and plumbing work steps in, especially where there are water-closets (Dublin is now entirely a water-closeted city); and it is of the highest importance for the welfare of a city that none but highly skilled men should be employed in work of this character, and that the young artisan should be properly trained in all the details of plumbing and drainage, and taught what are the effects of bad work on the public health.

We have in Dublin a Plumbers' Registration Association, in connection with the London Guild of Plumbers, who have an excellent school for night classes, where the young apprentice is taught the details of his business—a most important adjunct to the master's shop, and undoubtedly a gain to the masters, as the young men who attend such classes must prove more valuable to them.

ARTISANS' DWELLINGS.

The Corporation have not been unmindful of the Acts for providing better dwellings for the working classes, as they have cleared two sites, and let the ground to the company entitled the Artisans' Dwelling Company.

On the Coombe area the cost of clearance and rebuilding amounted to 52,000*l*., and on the Plunket Street area the cost was 46,245*l*. There are four classes of houses built on this latter.

		£	*s.*	*d.*		*s.*	*d.*	
No. 1	cost	64	0	0	and is let at	2	6	weekly.
„ 2	„	75	0	0	„	4	0	„
„ 3	„	80	10	0	„	4	6	„
„ 4	„	114	10	0	„	6	0	„

Benburb Street Buildings have been built by the Corporation at a cost of 27,500*l*.; they contain 144 tenements let at weekly rents varying from 1*s*. 6*d*. to 5*s*.; and at Bow Lane 43 two-storied houses have been similarly built by the Corporation, containing 86 tenancies, with rents varying from 2*s*. to 5*s*. 6*d*.

BATHS AND WASH-HOUSES.

Baths and wash-houses have been built in Tara Street at a cost of 14,000*l*. They contain a first class swimming bath 57 feet by 33 feet, and second class 64 feet by 26 feet, which contain 45,000 and 40,000 gallons of water respectively, and in addition there are 36 reclining baths, 8 being for women; there is a laundry and wash-house in addition, which is largely patronised. The space at the disposal of the Corporation was small, and consequently a portion of the work is rather cramped, but the baths are largely availed of by the parties for whose benefit they were intended.

Besides the new streets made and opened up for the purposes of Artisans' Dwellings, others have been made—notably Lord Edward Street at a cost of 69,000*l.*, and Tara Street at a cost of 19,800*l.*, and two others at a cost of 17,000*l.*

The Corporation also subscribe grants annually out of the rates to various hospitals, reformatories, and lunatic asylums, the amount for this year being 33,797*l.*, the grant for the Richmond asylum alone being 13,797*l.*, although the patients are brought there from all parts of Ireland, and until last year the Corporation had no voice in the management.

MARKETS.

The establishment of a regular market for the sale of cattle is recorded in the year 1541.

"*Item.*—Also, it is ordained by the said Assembly that the market place of all 'quyke* cattell' shall be in oxmantown green, and in no other place, upon pain of forfeiture, except sheep, lambs kids veals pigs and swine, geese capons and . . ."

The market then founded continued down to the present time and was not closed against the sale of cattle until the Privy Council declared it unsuitable for the purpose. It still remains a free market for the sale of hay and straw, and a scheme for repaving and enlarging it is now in contemplation, in accordance with an Act obtained last year by which the Corporation are enabled to levy tolls.

The Corporation had not alone the supreme control of the markets, but also regulated the sale of all food supplies within the limits of the city. Public weigh scales, according to entry in the rolls, were introduced in the year 1555.

"Forsomnch as it is very expedient in eschewing the great loss which the Citizens do sustain by excessive and untrue toll that weigh houses be builded for weighing all grain for the mills. It is ordered that whosoever will undertake the erection of such weight houses shall have of every peck a farthing, at going, and another of return. And he that most will yield unto the City for this room to have this grant, and that no person or persons shall carry any corn to any mill unweighed, on pain of forfeiture of 20*s.*"

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* Quick, alive.

The sale of fish is mentioned in the city laws from an early period, and in 1584 it was decreed as follows:—"Forasmuch as the inhabitants of Fish Street complaineth that they are greatly annoyed by such as bringeth fish to this city to be sold, by reason they sell the same in the doors of the said inhabitants, not only letting and hindering their recourse and the recourse of such as passeth the streets in those times, but also that the air thereof is likewise to be avoided; it is therefore agreed by the Authority aforesaid that some place elsewhere be appointed for that purpose, and therefore hereby we do authorise and appoint Mr. Mayor, Mr. John Lennan, Mr. Rounsell and Mr. Patrick Dowdall to appoint and find out a fit place where the said fish shall be sold, and the same to be builded on the City charge."

This enactment clearly points to the establishment of a retail fish market—a useful work which evidently became neglected and ultimately discontinued altogether. The necessity for such a market has been keenly felt of late years in Dublin, and the Corporation have promoted extensive markets, now in course of construction, in St. Michan Street, for the sale of fish, vegetables, and fruit and flowers.

This market is 330 feet long by 195 feet wide, and has an actual floor space of 64,603 superficial feet, and a further space of 8115 superficial feet is occupied by superintendent's office, caterer and refreshment rooms, stores, &c., making a total area of 72,718 superficial feet.

Longitudinally the market is divided into eight, and transversely into nine bays by rows of cast iron columns which support the roof. The columns stand on the average 19 feet 3 inches over ground line, finishing with moulded base and wrought-iron foliated capital. Springing from the top are a series of curved beams which support the ends of principal rafters carrying roofs. The principals are constructed of wrought iron and have a clear span of 41 feet.

The central portion of roof, for a width of 15 feet, is occupied by a lantern glazed on top, and the sides—which stand 2 feet 9 inches over roof line—are filled in with zinc louvres. One-half of the roof, from foot of lantern to gutter, is slated, while the remainder is glazed with $\frac{1}{4}$-inch fluted plate glass, thus securing ample light. Ventilation is effected by means of the louvres, arched openings to principal entrances, upper panels of entrance gates, and twenty semicircular openings 8 feet 3 inches wide.

The floor of markets is formed with cement concrete, having a finishing coat of Limmer asphalte laid with a regular fall to gullies, which are connected with cement-lined catch pits previous to discharging into main sewers in streets.

When designing the external elevations in Mary's and Fisher's Lanes, due regard has been paid to the predominant style of architecture in which the majority of the public buildings in this city has been built, and the Romanesque has been adopted in consequence.

The elevation in Mary's Lane shows a central gateway flanked by twin Corinthian columns having pilasters at back, these stand on a pedestal 4 feet 9 inches high, and support the entablature, which rises clear of blocking to side walls, and is surmounted by a group of statuary supporting a shield bearing the city arms. On either side of this entrance are six granite piers, standing on a boldly chamfered base, and finishing on top with a moulded cap from which spring semicircular arches of moulded brick, finishing with a hollow chamfered hoodmould; at the intersection of the latter are carvings typical of the trades transacted inside. The portion of the wall between hoodmould and cornice is faced with terra-cotta diaper, in squares of 18 inches, which is treated in a very bold manner, with conventional foliage springing from a central boss, each boss being connected with the adjoining ones by means of a bold bead, thus forming a continuous pattern over the entire surface. The wall is surmounted by a brick and stone cornice, finished with plain blocking.

Side entrances for the use of pedestrians are provided, having moulded brick jambs and heads finishing with moulded brick cornice surmounting ornamental terra-cotta frieze; over the doors are placed elliptical openings filled in with hammered ironwork. The height of the wall at this point is 21 feet 6 inches, while from ground to top of group of statuary is 36 feet.

Secondary entrances are provided at each corner, where the angle has been cut off and a gateway formed having an opening in the clear of 10 feet. These gateways are ornamented at side with pilasters standing on a pedestal, and surmounted with entablature and pediment, in the tympanum of which it is proposed to place a shield bearing an inscription giving date of opening, &c.

The space between piers is filled in with brickwork formed into panels by means of red brick jambs 14 inches wide. Co. Dublin stock brick is used in the filling-in between these jambs, and a finish is made at springing of arches with a 9-inch band of red and yellow bricks, over which is a 6-inch granite sill. Six openings are filled in with hammered ironwork as previously described, and a like number with red and yellow brick arranged in a pattern so as to avoid cutting and waste.

The elevation towards Fisher's Lane is treated in a precisely similar manner to that in Mary's Lane, excepting that it has seventeen arches, and the principal entrance is surmounted with a pedestal.

The internal elevation has been designed with a view to avoid projections on which dirt would accumulate, and surface decoration by means of judiciously applied masses of varied coloured local bricks has been relied on for effect. A glazed dado 5 feet high runs round the market and is finished with coloured bands of brickwork.

Cattle Market.

The Corporation have also built a very large cattle market at an initial cost of 30,000*l.* The market is built in the usual way, both cattle standings and sheep lairs being divided by iron standards with railings passing between. Each sheep pen is 16 feet by 6 feet and cattle standings 21 feet by 6 feet 6 inches; the roads are 20 feet in width, and alleys 8 to 11 feet.

The floors of sheep pens are of concrete, and the cattle standings of ordinary square sett paving.

The contents of the ground is 10 statute acres, and the market contains standings for about 5000 cattle and 14,500 sheep.

Within the last few years the salesmasters and others have evinced a desire to have the market entirely covered or roofed over, as a protection against the severe winter weather, and doubtless this will ultimately be carried out. At present two shelters have been erected temporarily where both salesmasters and buyers congregate.

Attached to the market is an hotel, also the property of the Corporation.

Abattoir.

Immediately adjoining the Cattle Market, but separated from it by the Circular Road, the Corporation has also built an abattoir standing on 9½ acres, for which is paid a rent of 318*l.* per annum.

In connection with this undertaking it is of interest again to refer to the ancient public records, by which we find in the year 1366 an enactment was made against butchers slaughtering beasts within the walls of the City, under penalty of forfeiture of hides. "This Act," the record states, "is intended to prevent the excessive and noxious stenches, hitherto caused by slaughter of cattle in this City."

This abattoir up to last year was on the county side of the road, but in the Act then passed, the defect was remedied, and abattoir and grounds are now within the City boundary. It was a mistake to build the abattoir in the county, as the Corporation were thereby left powerless to enforce its use.

There are still most of the old slaughter-houses in the City in full work, and undoubtedly it would be for the benefit of the City generally if all private slaughter-houses were closed; but the trade took care in the recent Act to protect itself, and the Corporation will now have to pay compensation for any of those houses which may be closed, so that it will be a work of slow progress.

There are 13 killing rooms, each 24 feet by 18 feet, behind which are the lairs. In the killing rooms white glazed bricks are used in the walls up to 5 feet high, the floors of both killing rooms and dead meat market are of asphalte: the latter is a large building 133 feet by 49 feet. There are all the usual adjuncts to an abattoir, viz. superintendent's residence within the grounds, gate-porter's lodge, car shed, stabling, hide store, tallow store, blood house, and out-offices. The Cattle Market and abattoir are connected by means of a subway under the South Circular Road.

The cost of construction of the abattoir was 15,000*l.*, but until the buildings are entirely availed of, the project will not be a financial success.

OPEN SPACES.

The advantages of open spaces for the recreation of the citizens were recognised in the olden times, for in 1635, the Commons petitioned the Assembly, praying that some course might be taken in the said Assembly "whereby no part or parcel of the greens and commons of this city, viz. Hoggen Green, St. Stephen's Green, and Oxmanton Green, might not from henceforth be set or leased to any person, but that the same may be wholly kept for the use of the citizens and others to walk and take the open air, by reason this City is at this present growing very populous. It is therefor enacted by the authority of this Assembly, that if the Mayor of this City for the time being shall give way to the reading of any petition or bill which shall be hereafter for the leasing or disposing of any part or parcel of the aforesaid greens and commons that he the said Mayor shall forfeit 40*l.* sterling English money for every such offence, to be deducted out of his entertainment (i. e. salary) and allowances."

This excellent Act of the Assembly somehow became void, and seems to have been forgotten through a great many generations, but happily however Stephen's Green, one of the places mentioned in the Act, has been within the last fifteen years, and through the munificence of Lord Ardilaun, restored to the citizens as a place where they can freely "walk and take the open air."

A small space, called Queen's Square, has been also thrown open to the public, at a cost of 1600*l.* to the Corporation.

Public Libraries.

There are two public libraries in Dublin—one on the south side and one on the north. These houses were not specially built for the purpose, but were ordinary houses remodelled for the purpose at a cost of about 2500*l.*

Both houses are well attended, being largely availed of by the classes for whose use and enjoyment they were established.

Electric Light.

In accordance with powers obtained, the Corporation of Dublin have now in course of construction a central electric lighting station to supply the first area covered by their license.

The streets through which the mains for public and private lighting will now be carried, are as under:—

Westmoreland Street,
Sackville Street,
Mary Street,
Grafton Street,
College Green,
College Street,
D'Olier Street,
Henry Street,
Dame Street,
Parliament Street,
Capel Street (part of);

provision being made for future extension of the area as required.

The public lighting will be by means of Brockie-Pell single carbon arc lamps in series, taking a current of 10 amperes and 50 volts, and arranged to burn 16 hours without re-trimming. They will be fixed on iron lamp-posts 21 feet high to centre of lamp, of ornamental design, and fitted with weather hoods and opalescent globes; in the base of each post will be fitted a special short-circuiting switch, to enable any lamp to be completely isolated from the circuit when necessary, and alternate lamps will be on different circuits to avoid the total extinction of light in case of temporary interruption to any one line of conductor.

The current will be generated by Brush dynamos, and will be kept constant by an automatic regulator.

The supply for the private lighting will be on the "high tension alternating current transformer system," the pressure in the street mains being at 2000 volts and reduced by transformers in the consumers' houses to 50 or 100 volts as desired. The transformers are guaranteed to reproduce in the secondary circuit 95 per cent. of the energy absorbed in the primary circuit at full load, and not less than 75 per cent. at half load, and will run continuously without overheating.

They will be enclosed in water-tight cast-iron cases, unless fixed in a fireproof chamber, and safety fuses will be interposed at both high and low tension mains at the point of connection with the transformer.

The amount of energy consumed will be registered by reliable meters of the Shallenberger type, with a guaranteed accuracy of 95 per cent.

The mains for both public and private lighting will be carried in cast-iron pipes laid under the footways, the joints being made with gaskin and lead.

Junction boxes of the Lowrie-Hall pattern, as used in Madrid and West Brompton, will be fixed at intersections of the streets, drawing in and service boxes being interposed as required, and all being properly drained and fitted with water-tight covers.

In every street throughout the area a 3-inch pipe will be laid on each side of the road, and on one side or other of every street a 4-inch pipe will also be laid, with some few exceptions, when either a 5-inch or 6-inch pipe will be substituted; the service pipes to the arc lamps and consumers' houses being $1\frac{1}{2}$-inch wrought iron.

The conducting wires will be of high-conductivity copper wire, heavily insulated with vulcanised indiarubber and taped, and will have a minimum insulation resistance of 5000 megohms when laid and jointed in the pipes. The smallest size of wire allowed will be $\frac{7}{18}$ B.W.G. in area, and a "go and return" conductor will in all cases be laid in the same pipe.

The generating plant is being erected upon land belonging to the Corporation, situated at the back of the Bank of Ireland, and will cover an area of about 12,000 square feet, with room for future extension.

The frontage in Fleet Street is of red brick with granite string courses, and comprises a three-story building in which the various offices, stores, switch and test rooms will be placed, and a machinery hall 100 feet long, 50 feet wide and 40 feet high, the latter being ventilated by swing windows in the sides and skylights in the roof.

At the back of these buildings, the boiler house, coal stores, and water tanks are placed, and at one end a brick chimney 120 feet high from ground level is being erected.

The foundations for the walls of main buildings are of cement concrete, and are carried 12 feet below the ground level, the foundations for the engines, dynamos, and chimney being carried some 2 feet lower, to the solid rock.

The engines selected for driving the private lighting plant are being built by Victor Coates & Co., of Belfast, and consist of three pairs of coupled compound non-condensing horizontal engines guaranteed to realise 280 horse-power on the fly-wheel of each pair, with steam pressure of 140 lbs., and running at 85 revolutions per minute, the diameter of the high pressure piston being 17 inches, the low pressure 34 inches, and the length of stroke 36 inches.

Each cylinder is fitted with Corliss valves worked by two eccentrics with special release motion, the governor also being of specially designed high-speed type and fitted with compensating gear which will control the speed within a maximum variation of 5 per cent. under any circumstances, and after a short space, when settled, will control it to 1½ per cent. variation.

The crank shaft is of Siemens-Martin mild ingot steel 11½ inches diameter, and swelled to 13 inches where the fly-wheel keys on, the main bearings being 10 inches diameter and 18 inches long.

The fly-wheel, 14 feet in diameter, is built in halves carefully fitted together, and has a total weight of 9 tons, of which 5¼ tons is in the rim, the latter being grooved to take twelve 1½ inch ropes.

All moving parts are furnished with very complete oiling arrangements, enabling the engines to run continuously if required.

Each of these engines is coupled direct by twelve $1\frac{1}{2}$ inch ropes of Egyptian cotton to a 150-unit alternating current dynamo of the Lowrie-Hall type, with stationary armature and revolving field magnets, with an output of 75 amperes at 2000 volts, the approximate speed being 350 revolutions per minute, and the efficiency at full load guaranteed not less than 88 per cent. including the current required to excite the field magnets, the fields having 28 pole-pieces, giving approximately 4900 complete phases per minute.

The pole-pieces are securely attached to a solid wrought-iron ring, the insulation resistance between the coils and cores being not less than five megohms.

The armature core is built of laminated charcoal iron sheets insulated by mica from the conductor coils of copper tape, the insulation resistance between armature coils and core being a minimum of 15 megohms, and the ends of the coils terminate in an insulating box fitted with terminals mounted on a damp-proof base, the insulating resistance between the terminals being 100 megohms.

The whole is carried on an extra deep box-pattern base plate by mild steel shaft 6 inches diameter running in two plummer blocks and having a total bearing surface equal to six times the diameter of the shaft; the bearings are of hard phosphor bronze, in halves, and fitted with special swivelling arrangement, and each plummer block is arranged to allow of a stream of water circulating round the bearing.

The exciting current is collected by two phosphor bronze rings on the shaft, carefully insulated; each ring is provided with two sets of brushes and holders.

Each alternator is provided with a separate exciter driven by four $\frac{3}{4}$ inch ropes from the dynamo shaft; they will be series wound drum armature machines running at 800 revolutions per minute, and both alternators and exciters are fixed on sliding rails with tightening arrangement to allow of adjustment while running.

The public lighting plant will be driven by three vertical compound engines, each capable of realising 60 brake horse-power at a speed of 220 revolutions per minute with steam at 140 lbs., the high-pressure cylinder being 9 inches diameter, the low-pressure 15 inches diameter, and the stroke 10 inches; the cylinders will be fitted with automatic and hand expansion gear adjustable while the engine is running, and the governor will be of a specially sensitive high speed type.

The fly-wheel will be 8 feet diameter, the face being grooved for rope driving, and the main shaft runs in three bearings.

The lubrication throughout will be from stationary lubricators of combined syphon and drop feed type, designed for continuous running.

The current is generated by three Brush arc lighting dynamos, each capable of an output of 10 amperes and 3000 volts at 800 revolutions per minute.

The armatures are of laminated iron, wound with coils in twelve recesses, the opposite coils being connected in series, the free ends of the coils being brought through the hollow shaft to the commutator, each machine being mounted on sliding rails with the necessary tightening arrangements.

The current is kept constant at 10 amperes by means of a Brush-Geipel automatic regulator, consisting of a series of carbon plates interposed in the main circuit, and the resistance of these being varied by lever pressure, actuated by solenoids connected as a shunt across the dynamo fields.

Two main ranges of wrought-iron steam pipes 8 inches diameter extend the entire length of the engine room, and each range is so connected with the other, with the engines, and to the boilers, and fitted with stop-valves, that any section of the steam pipe may be removed while under steam, without interfering with the supply to any engine.

The stop-valves used are of the "sluice valve" type with projecting spindles, and all joints are properly faced before being made.

The main exhaust pipe is of mild steel, 12 inches diameter, the branch exhaust pipes from the engines being suitably curved to connect with this to avoid any back-pressure; it will be carried under the engine-room floor, and covered in with removable cast iron grating. An overhead travelling crab, lifting 8 tons, permits easy handling of any of the machinery in case of break down.

The output of the plant thus installed is equal to 120 arc lamps of 500 watts each and 5000 incandescent lamps of 60 watts each being in use at one time, with one complete spare plant in reserve in each case.

The switch room, situated on the ground floor of the office building, is separated from the engine room by a glazed partition, and will contain three complete sets of Lowrie-Hall automatic regulating apparatus to maintain a constant E.M.F. at the terminals of the alternators; this is effected by placing a shunt of varying resistance across the field of the exciter.

The main switch-board for the private lighting plant is also of Lowrie-Hall design, as used at West Brompton station, the base being entirely of slate; the metal sleeves which are connected to the dynamo leads and circuit mains are mounted in porcelain blocks, so arranged that the operators cannot accidentally come into contact with the high tension circuits, the cross connections being made with a double switch plug mounted on an ebonite base.

By means of these plug switches, any two or more of the alternators can be coupled on to two or more of the mains, that any main or alternator not so connected can be added at will, or that any alternator can be put on to any main separately.

Fusible safety junctions are fitted on the board at the points of connection with the dynamo leads and mains, and the connections are carried under the floor in brick trenches with movable covers.

A synchronising board is fixed over the main switch-board, to enable the alternators to be run in parallel when necessary, with the requisite instruments to show when the machines are cophasal.

The pressure in the mains is indicated by Cardew voltmeters with large dials, and is checked on one of Sir William Thompson's standard voltmeters; the current for these is supplied by small converters arranged behind the switch-board, spare instruments are held in reserve with the necessary appliances for re-calibration.

The current from the alternators is registered on ammeters on arrival on the switch-board, and the outgoing current is also registered on ammeters fixed on the mains where they leave the board, the standard ammeter being one of Sir William Thompson's.

The switch-board through which the current from the exciters passes to the alternators is provided with a switch on one side of each circuit, and a fusible safety junction on the other, ammeters are interposed in the circuits, and a Cardew voltmeter with large dial is connected to a six-way switch to enable the pressure in any circuit to be ascertained.

The switch-board for the public lighting plant is fitted with three main switches and three circuit switches, arranged so that any of the circuits and dynamos can be interchanged; the three circuits can also be placed in series, and run off one machine if desired. An amm ter is interposed in each circuit.

The test room, which is placed adjoining the switch room, is fitted with a very complete set of intruments for testing the condition of the various circuits and machines, and recalibrating the numerous ammeters and voltmeters in use in the station; the adjustment of meters and testing transformers will also be carried out here. The Thompson reflecting galvanometer is mounted on a concrete pillar, carried some 12 feet below the ground-line to minimise vibration. The Wheatstone Bridge and testing battery will be permanently connected on an insulated testing table in a convenient form.

Steam will be generated for the engines in four Babcock and Wilcox water tube boilers, each capable of evaporating 8500 lbs. of water per hour at a pressure of 150 lbs. on the square inch, the coal consumption at full work being guaranteed not to exceed 1 lb. of Welsh steam coal for every 9 lbs. of water evaporated.

The total heating surface in each boiler is 2530 square feet, of which 51 square feet is grate surface.

They will be set in batteries of two, the brickwork being faced with white glazed brick bedded in fireclay, and each boiler will consist of 14 sections of eight lap-welded wrought-iron tubes 4 inches diameter and 18 feet long, fitted in the usual way, and connected at each end with "up-takes" and "down-takes," to two steam and water drums 36 inches diameter and 23 feet 7 inches long, built of $\frac{3}{8}$-inch steel plates, the longitudinal seams being double riveted.

The boilers will be suspended from wrought-iron girders supported on cast-iron pillars, and will be entirely independent of the brickwork; they will have the usual steam and water fittings for boilers of this class, and will be subjected to a hydraulic test of 250 lbs. on the square inch after erection.

The boilers will be fed by three Worthington steam pumps, each one capable of supplying sufficient water to two of the boilers when fully loaded, and arranged so that any boiler can supply any pump with steam, entirely independent of the main steam pipes.

Water tanks capable of holding a supply for five hours at full load will be erected on brick piers over the coal store, and a direct connection will be made between the Corporation water main and the steam pumps, to be used in an emergency.

The feed-water will be passed through three of Berryman's feed-water heaters, each heating a sufficient quantity for two of the boilers at full load; they will be placed at the foot of the chimney, and by means of suitable by-passes and valves the exhaust steam can be sent through any or all of the heaters, or past them direct into the chimneys.

The main flue will be built of firebrick, sides and top set in fire-clay, with a concrete bottom; the base of the chimney will be lined internally for 20 feet with a ring of firebrick with a 2-inch air space between. The chimney itself has a solid bed of concrete, 20 feet square and 3 feet thick, resting on rock 16 feet below the ground level, and will have a total height of 140 feet, the internal diameter being 8 feet. It will be fitted with a solid copper tape conductor with rod and points, and will be earthed on the 6-inch water main supplying the station.

The Corporation will bring their surface lines, free of expense, to any consumer's premises situated within 30 feet of any of their mains, an extra charge being made for any greater distance, and in all cases the consumer's installation must be passed by the Corporation Inspector before connection will be completed, and be in accordance with the rules laid down by them to secure efficiency and safety.

The transformer and high-tension safety fuses supplied by the Corporation, when not inclosed in an iron case, will be placed in a suitable protecting chamber supplied by the consumer.

A double-pole switch and safety fuses will form part of the consumer's installation immediately where the low-tension circuit leaves the transformer case.

The charge to the consumer will be either by special contract or by meter as may be desired, the minimum charge per quarter being 2*l.* for any quantity up to 60 units. For any quantity over 60 units and under 100 units per quarter, 8*d.* per unit. For any quantity over 100 units per quarter, 7*d.* per unit.

Hire of meter per quarter, 5*s.*

Hire of transformer, primary safety fusible cut-outs—

	£	*s.*	*d.*
For 25 16 candle-power lamps per quarter	0	5	0
„ 50 „ „ „	0	10	0
„ 100 „ „ „	1	0	0
„ 150 „ „ „	1	10	0
„ 200 „ „ „	2	0	0

The meters will of course be fixed on the low-tension mains, their accuracy being guaranteed by the Board of Trade Inspectors, and the current will be available for 23 hours per diem.

The entire cost of the works as at present designed will be about 31,000*l.*, and will be maintained by, and kept under the control of, the Corporation.

ROAD MAINTENANCE.

By R. H. DORMAN, County Surveyor, Armagh, Ireland.

Since the commencement of the present century the general condition of the public roads throughout the United Kingdom has undergone a vast improvement, and although the laws which regulate road maintenance and county work in Ireland differ from those in force in England and Scotland, and to some extent retard progress, yet the author thinks he is correct in stating that the general condition of the county roads in Ireland is not very much behind similar roads in the sister island.

The Grand Jury laws of Ireland, skilfully framed and apparently well adapted for their purpose fifty years ago, are insufficient for the requirements of the present day; they require at least enlarging. The following are some of the defects in the system which require early amendment.

1. The Grand Jury of each county only meet for the consideration of fiscal business twice a year—in March and July—and contractors only receive payment on these two occasions in the year.

2. The necessity of accepting the lowest tender at adjourned sessions for any work, provided the person tendering and his sureties are willing to be bound for the performance of the contract in a penal sum double the amount of the sum mentioned in the tender. This clause in the Act practically puts bad contractors on an equality with good contractors in the matter of tendering.

3. The remedies against defaulting contractors are insufficient.

4. No provision is made in the Act for the purchase of steam rollers, tools, instruments, or appliances of any description.

5. The cost of erecting each mile-stone, direction-post, or stone depot for materials shall not exceed 1*l*.

6. No travelling expenses can be granted either to County Surveyors or to their assistants; for example, in the county Armagh the author's travelling expenses amount to over 80*l*. per annum, which has to be paid out of a moderate salary.

The works usually in charge of a County Surveyor in Ireland are somewhat varied, and include :—

1. Maintenance of public roads and footpaths, and the construction of new ones.

2. Maintenance of bridges, retaining walls, fences, pipes, &c., and the construction of new ones.

3. Hill cuttings and other improvements to public roads.

4. Maintenance of courthouses and other public buildings.

5. Superintendence of tramway construction and other works which entail interference with the county roads.

6. Maintenance of certain piers, quays, landing slips, &c.

The number of miles of roads under presentment is over 51,000, maintained at a total cost of about 700,000*l.* per annum, or 13*l.* 14*s.* per mile. The number of County Surveyors is 43, and Assistant Surveyors 158, the cost of supervision averaging 5·28 per cent. on the expenditure. In the county of Armagh there were, during the year 1890, 1613 miles of road under presentment, maintained at a cost of 20,544*l.*, or 12*l.* 14*s.* 9*d.* per mile; in addition, the cost of special works amounted to 2827*l.* To keep our roads in good order at the smallest possible cost is the chief object to be kept in view in road maintenance; and the author is satisfied no system can compare with the contract system as adopted in Ireland on the score of economy.

Broken stone and gravel are the materials exclusively used for repairing country roads in Ireland; in some of the larger towns squared setts and cobble paving are a good deal used; but wood, asphalt, and similar materials have only been tried on a very limited scale. Since cobble pavements are universally condemned, the author proposes dealing in this paper only with macadam and stone pitching in connection with road maintainance.

Action of the Weather.—The weather is an important factor in connection with road maintenance. We have too much sun in summer and too little in winter. In continuous dry weather the wind as a dust-carrier creates a nuisance, while during and after rain it is beneficial. During long continued dry weather occurring at any period of the year, a high wind is most injurious to roads; the author has known roads break up just as badly in March as during any period in the summer, owing to the wind blowing all the fine particles off the surface and from between the broken stone. The effects of rain and frost are too well known to need discussion, but whereas occasional rain is beneficial to a road, frost appears to be at all times injurious, and further that during alternations of rain and frost it is almost impossible to keep a badly bottomed road in order.

Trees and Hedges.—No matter whether a road lies high or low, if it is overhung by trees it will be found to be constantly damp; this is most noticeable in summer when the trees are covered with foliage. A neatly cut hedge, well set back from the travelling way of a road, is about the best form of fence that can be devised; but when overgrown they become not only an obstruction to the traffic, but they shut out the sun and wind from the road surface. Although provision is made by Act of Parliament whereby owners who refuse to lop their trees or cut their hedges, on being noticed, can be compelled to do so, yet summoning such persons to Petty Sessions is one of those unpleasant tasks which a County Surveyor is anxious, if possible, to avoid.

Drainage.—The water level should be kept at least 2 feet below the road level; this is however not always possible. The author has several roads under his charge which are constantly covered with water during flood time, and several roads in the neighbourhood of Lough Neagh are so covered for prolonged periods during the winter months. Keeping the outlets and side channels clear and the surface free from water is of nearly as much importance as the drainage of the subsoil. If, owing to inequalities on the surface, water is allowed to lie in the hollow parts, it gradually soaks into the body of the road, softening the binding material, and the stones having lost their mutual cohesion, work on one another, and wear and tear goes on nearly as rapidly in the body of the road as on the surface; this action is of course greatest on a weak or badly bottomed road. To show the excessive wear and tear which goes on on a badly bottomed road as compared with a hard road, the author may mention two short lengths of road under his charge. The first length of road is very badly bottomed, it is also too flat in section and may be considered as a thin coating of hard whinstone resting on clay. The second length of road has a better bottoming, the top coating is considerably thicker and it is rounder in section. The traffic on each length amounts to about 1200 collars per day, but the amount of material required to repair the first length of road is at the rate of 1200 tons to the mile, while on the second length it only amounts to 800 tons to the mile per annum.

Repairs.—Except in the neighbourhood of Belfast, steam rollers have not yet been introduced on country roads in Ireland, and the road metal has to be consolidated by the traffic; the practice of picking up the surface before spreading on new material is also little attempted. The author does not consider it advisable to hack up a road, except when repairs are absolutely necessary in the spring and summer months, and then only when laying material on a hard road. If the bulk of the stone necessary for the repair of a road be laid on in damp weather during the months of October and November, it will take but a short time to work in; the stone should be spread off in sheets on alternate sides of the road, on hard roads the sheets should be kept thicker than on soft roads, and on hills the sheets should extend from the channels to rather beyond the centre of the road, the top corner next channel being cut off to allow the surface water an easy flow to channel; petty repairs should be effected by lightly picking in the wheel tracks as they form, and spreading off small patches as required. The author does not consider it necessary to add any binding material when roads are repaired in the above manner, but the surfacemen are directed to sweep any mud or dust which may accumulate round a sheet on to it; this facilitates the binding and helps to keep the sheet together. In summer, however, it is sometimes found desirable to spread off some blinding on roads repaired with whinstone and similar material, to prevent the stones from rolling. Well drained, but badly bottomed roads, break up far sooner than any other class.

Steam Rollers.—For repairing main roads and streets of towns in Ireland it is high time to introduce the steam roller, and the author does not despair of seeing the day when rollers will be considered a necessity for all road repairs. An Aveling and Porter ten-ton roller can consolidate from 800 to 1000 square yards of roadway in a day of ten hours, much depending on the quality and quantity of the binding material used. The author estimates four rollers would be required in the County Armagh to deal with the main roads, at a cost of about 2000*l.* per annum. He would be glad to hear if any members of the Association have had experience of rolling in very soft material, such as white limestone; and considers a six-ton roller would be as much as such material could bear.

Surface-work.—The best method is to employ a foreman with a gang of men under him to attend to the roads in separate districts; in Ireland, however, it is the custom to employ one or more men to attend to each main road contract, it is not usual to employ regular surfacemen for the bye roads. If hardworking and intelligent men could always be obtained for this purpose, there would be little objection to it; but unless carefully supervised, the men are apt to become careless, and frequently absent themselves from their work. In the County Armagh the amount of surface-work required in winter varies from one man to one-third of a mile to one man to five miles of main road. If the contractors could be induced to purchase horse brooms and slop carts, the manual labour would be much reduced, but so far only hand scrapers and hand scraping machines are in use to remove mud; these are also used to remove dust in summer on the limestone roads.

Road Materials.—More than one-half the roads in Ireland are repaired with limestone or limestone gravel, and for light traffic the blue limestone or limestone gravel makes an excellent road. The white or grey limestone is very inferior and wears rapidly. In the County Armagh the materials available vary very much in quality; over a large portion of the Baronies of O'Neilland West, Armagh, and Turany the white limestone only is available, and the amount of stone necessary to maintain the roads, and the amount of mud created, and consequent surface work, is enormous. In the east and south of the county, whinstone, slate stones, granite, and elvanite are available; the whinstone makes excellent metal, the slate stones vary in quality, the granite is generally coarse grained and unsuitable for heavy traffic, the elvanite is superior to granite.

Great difficulty has been experienced during recent years in County Armagh in obtaining hand broken stone in sufficient quantity. The amount of stone required annually for road repairs amounts to about 80,000 cubic yards, of which a small proportion is machine broken; the strength of the stone undoubtedly suffers in passing through a machine, and there is a considerable amount of fine residuum for which there is little demand; notwithstanding this, and since they are still in their infancy, and many improvements may be expected in them in the future, the author anticipates their coming more largely into use in this country. Two of the chief objections to them are their first cost and great weight, and contractors hesitate to invest their money in such unwieldy monsters. The class of machine required in Ireland is:—

1. A machine which can be easily moved from place to place, like a thrashing machine.
2. A machine which can adapt itself to all qualities of stone.

3. A machine which will produce cubical stones without reducing their strength, and which produces little waste.

4. A machine which can be put in motion by steam, hydraulic power or animal power; if turf could be used for fuel it would be an additional advantage.

5. A machine strong but simple in construction.

While dealing with machinery the author would like to make a few remarks on steam tramways and traction engines on public roads. Under the Tramways (Ireland) Act 1881, tramways or light railways may be constructed on the public roads, provided the speed be limited to ten miles an hour and a minimum width of 18 feet be left between the outer tram-rail and the opposite fence or footpath; in the County Armagh a short length of light railway has been constructed on the side of the public road, leaving only a width of 14 to 15 feet between the end of the sleeper and footpath; the consequence is that the road has been rendered most dangerous for animal traffic. Traction engines are also a source of danger, but if proper precautions be taken the danger may be minimised. The author's experience of them is that they do considerable damage on soft roads, but very little on good hard roads. The chief danger apprehended from them is in passing over pipes and bridges; there is frequently a more or less sharp rise over a bridge, and when the full weight of the engine is over one of the haunches it is very apt to injure the arch, the vibration of the engine also tends to shake the structure.

Improvement of Bad Roads.—The following are some of the methods adopted by the author for reforming roads in bad order and out of shape:—

1. When there is a good thickness of metal in the road, but road hollow in centre and too high at sides. During the summer months the sides are picked off and the material screened, the fine stuff is kept for the footpath, and the coarse stuff applied to centre of road.

2. When the depth of metal is very thin. Thick sheeting applied annually will of course after a time bring the road to a proper section, but if the traffic is considerable and road badly bottomed, it should be pulled to pieces, the formation surface paved with quarried stone 6 to 8 inches deep set on edge and coated over to a depth of 6 inches with sound stone, blinded with clean gravel or sand. The leading road from Armagh to Monaghan is a good example of a road of this class; it is a low lying road, badly drained and badly bottomed, and consists for the

greater part of its length of about 3 to 4 inches in thickness of mud and broken stone resting on clay, while both sides are adorned with large banks of mud. A presentment was approved at Sessions for spending 1000*l.* on re-making 200 perches of the road, but it was thrown out before the Grand Jury. As regards the expenditure in this case, after deducting cost of footpath, stone depots, removal of mud banks, &c., there would be left a sum equivalent to about 1*s.* 6*d.* a yard for excavation, bottoming, &c., barely sufficient for the purpose. Owing to the opposition offered to the work, on the ground of expense, the idea is now given up of bottoming the road, and it is proposed to apply an additional quantity of broken stone to it every year, but it will take several years before it can be got even into fair condition by this method.

3. When the travelling way is too narrow and road too high in centre. During the summer months the top of the road should be picked off and material taken off applied to the sides. If the sides are very low, they should first be made up with pitching or clay to the required level; in the County Armagh, very few of the roads are properly bottomed, and it is sufficient to side the roads with good clay rammed in layers before applying the top metal. By this method roads are converted which were always in bad order into a fair state of repair.

Cross Section.—The cross section of a road should vary with its hardness and with its longitudinal slope. On level roads 1 in 24 is a suitable transverse slope where limestone or gravel are the materials used, 1 in 30 for slatestone, and 1 in 36 for hard whinstone roads. On hills the camber should be increased—for instance on an incline of 1 in 30 with transverse slope of 1 in 30, if the surface is perfectly smooth, the water will flow off the road into the side channels at an angle of 45°, but as all roads tend to become tracked longitudinally, the author would recommend the transverse slope on hills being made greater than the longitudinal slope.

For the cross section of a road a flat elliptical curve for three-fourths of the width is preferable, and the shoulders well filled out.

Bog Roads.—Roads constructed over peat bogs are very liable to get out of shape, owing either to the movement of the bog, to one or both sides being cut away, or to the traffic; in the latter case, owing to the bulk of the traffic passing over the middle of the road, the centre becomes depressed and the sides rise; no remedy appears to have been found yet to prevent this distortion of bog roads.

In many counties the cutting down of bog ramparts is an important item of expense. It is very difficult to prevent persons cutting turf right into the travelling way of bog roads, sometimes the turf is cut away to a depth of 20 feet below the road surface, and of course when this is done the rampart commences to split longitudinally and rapidly goes to pieces, necessitating the whole being cut down. In carrying out such work, the metalling having been put on one side, the top of the peat, say for 2 feet in depth, should also be kept, and as soon as the rampart has been cut down, the top peat being dry and fibrous should be placed on the newly cut surface ; over this should be spread a thick layer of whins, and over this again a layer of clay or loamy gravel at least 6 inches thick ; after allowing a little time for this to consolidate, the broken stone may be spread off and blinded with sand or fine gravel. This description of work should always be carried out during the summer months.

In making new roads over bogs the method usually adopted is to cut deep drains on each side of the proposed roadway and some ten feet back from the line of fences, the stuff taken out being spread over floor of proposed roadway ; small transverse cuts are also made at frequent intervals and field pipes laid down and covered over. When the bog has been well drained, it should be brought to a fair level and covered with layers of sods until formation surface of proposed roadway is at least 2 feet over flood level ; on this surface should be spread a layer of whins, then a coating of clay or loamy gravel 9 inches thick, and when this has consolidated the top metal can be spread off. It is useless to put a pitched foundation in a bog road, as the stones lose their position in a short time, and either rise to the surface or get lost in the bog.

Bye-roads.—Narrow bye-roads, termed "loanings" in the County Armagh, allowing only room for one cart, are difficult to maintain in good order. The author usually has a portion of these roads, about one-tenth, sheeted each year, and repairs effected by filling in the wheel tracks, but the method is unsatisfactory. On hills the difficulty is intensified ; there is no room for water tables, and very often the land on either side is higher than the road, so that all surface water, unless covered drains are put in, has to flow over the hills, probably for some distance before it can find an outlet. Even on a hilly road 12 to 14 feet in width, farmers object to water tables being formed, on the ground that they cannot work their horses across the roads with a load ; they want a road flat in cross section going up, while going down they want a channel to put one of the cart wheels into.

Foot-paths.—Country foot-paths are usually 4 feet 6 inches to 6 feet in width. In the County Armagh, chisel-dressed granite (Newry and Bessbrook) and limestone, also roughly squared stones, rough stones and sods, are used for kerbing. The dressed stone is specified 12 inches by 6 inches when laid flat, and 5 inches by 10 inches when laid on edge. The cost of completing a foot-path with this class of kerbing comes to 3*s.* 6*d.* or 4*s.* per lineal yard, a channel of cobble stones, 15 inches wide costing 6*d.* a yard extra. The Newry or Bessbrook granite makes excellent kerbing, laid either flat or on edge; the limestone is better laid on edge, as it wears very smooth on top. A sod foot-path costs from 1*s.* to 1*s.* 9*d.* per yard, and with a squared limestone kerbing 2*s.* 9*d.* per yard. Undressed stones the author has ceased to use. For a new foot-path the filling is composed of good hard material, over this is spread a layer of clean broken stone, and on this two inches of gravel, of granite, whinstone, or limestone chippings; the gravel used should be of medium size and free from earth, if it does not bind quickly it can be blinded afterwards with a little clean sand. The granite, whinstone, or limestone chippings from a machine, make excellent material when screened, but when the fine residuum is left in, the surface wears quickly and becomes very dirty in damp weather.

Stone Pavements consist of squared setts laid on a suitable foundation, the foundation usually consists of gravel, broken stone, or concrete of various thicknesses; this latter is the only reliable material, it should never be laid less than 6 inches thick, while 9 inches will carry the heaviest traffic. Portland cement and Thames ballast in the proportion of one to seven make excellent concrete. As the concrete is laid in the trench the top surface should be brought to the proper camber with the shovel. In Dublin the author recently noticed the concrete was lightly rammed; while in India he was taught to have concrete thoroughly rammed until the lime or cement creamed to the surface, but this appears to be an unnecessary and even injurious proceeding, particularly when a good cement is used.

Setts.—Granites of various qualities, whinstone, and occasionally sandstone are employed. For ordinary traffic Aberdeen or Newry granites are largely used. For very heavy traffic it is advisable to use greenstone or a hard granite; owing to the extreme hardness of greenstone, it is very difficult to dress, and in consequence the neatest looking pavements can be made with granite setts. Asphalt, an asphaltic mixture, and wood have been suggested as materials for packing, but they are seldom used, owing to the expense; sand and gravel are commonly used. When the foundation consists of broken stone or similar material, gravel is probably the best packing material, but it is not suitable for use on a concrete foundation; it is far easier to bed a stone on sand packing than on gravel, and when well rammed it will take an even bearing, but a stone laid on gravel is liable to rock and work loose. Formerly it was usual to bed each stone in lime mortar, no doubt a good method, but expensive.

Grouting.—In the North of England, Dublin, and other places, the joints are first filled with clean pebbles, after which the surface is well rammed and then run with an asphaltic mixture, and covered with a layer of fine gravel. In the South of England, the grouting usually consists of sand and lias lime or Portland cement. As regards the comparative advantages of lias and Portland cement as a grouting, lias is the best substance to use when there is a probability of the pavement having to be disturbed from time to time to relay pipes, &c. Lias should also be used when the setts are of a slippery nature; one advantage of lias grouting is that it always appears to have some setting properties.

When the paving is not liable to be disturbed, Portland cement is the best grouting for Newry, Aberdeen, and similar setts; the grouting and the setts wear pretty uniformly, and the stones do not work so round on the top as when a soft grout is used. When a cement grout is used the traffic should not be allowed over the surface for three or four days after the work is completed, as if the traffic is allowed over, many of the stones will work loose, and will of course remain so unless fresh grouting is run in; once, however, a pavement grouted with cement becomes thoroughly set, the heaviest traffic will not disturb the stones. Finally, while admitting the superiority of the "Manchester" grout with hard setts, the author has a strong predilection for cement grout for the less durable setts, when laid on level ground.

Laying the Pavement.—The setts should be laid touching one another, each stone should be so firmly bedded on the packing that it has not to rely on its neighbour for support; the packing should average 1 inch in thickness and there should be no pebbles in it, as if a pebble gets between the concrete and a sett it cannot be rammed, and will always rock. The rammer men require careful supervision; to avoid the trouble of lifting badly laid setts they often try to get an even surface by ramming the high stones extra hard, and omitting to ram the low lying stones or stones inclined to give too much. Care should be taken when laying the pavement to see that the setts break joint. The rounding of the setts on the top is usually ascribed to the action of the wheels, but it is rather due to the cogs on the horse's shoes.

In conclusion, the author has to express surprise that so few experiments are being made in the present day for the purpose of ascertaining the draught over different surfaces, the comparative merits of roads formed of different materials, how surfaces are affected by velocity of motion, and kindred matters; and that so little has been attempted to ascertain mathematically the resistance to rolling over different surfaces and with different velocities, the most economical means of doing work with animal power, the effects of inclinations, the development of grades, &c. The author had hoped to prepare a paper dealing with these matters, but found there was so little data to go on that a paper on these subjects would entail more labour and thought than he could afford to give in the limited time at his disposal, and was therefore obliged to fall back on his own practical experience, and to present you with a paper which can be of little use to the older members of the Society, but which he trusts may be of some assistance and interest to young surveyors.

DISCUSSION.

Mr. E. Pritchard: First of all I wish to express my thanks to the gentlemen who have read the papers. It is quite a pleasure and refreshing to find that gentlemen who have so recently been connected with our Association should give us such interesting papers. Mr. Harty has given us a paper we can say very little about. It is most interesting and instructive as a matter of history, and so far as the construction of the works which he has described and taken part in, the paper must be instructive to every member of the Association. I give to the authors of both papers my best thanks, and I am sure they will receive the thanks of all the members of this Association. It is a matter of great interest to the engineers from the Sister Isle (as I suppose we must now call the other side) that we should now be in Dublin, and I re-echo the wish which has been expressed by our President, that we shall again be in Dublin before long.

With respect to the papers I have very little to say, but there are one or two points in Mr. Harty's paper upon which I should like to make some observations. In the first place, Dublin must be complimented upon having such a satisfactory water supply—a supply of such purity, of such abundance, and at so small a cost.

Without going over the same ground as Mr. Harty, I would like to comment upon the question of purity. It is a water of remarkable purity, and every one who reads the analysis given in Mr. Harty's paper will be surprised to find that so pure a water has been found in such abundance within so easy a distance of Dublin. When we go a little further and find the cost of this scheme to be 660,000*l.*, for supplying water to a population of 350,000, and with an abnormal quantity of water used per head of the population, we see that Dublin has obtained at a small cost a supply of water which it will not be necessary to augment for many years to come. Now Dublin has obtained its supply of water from this source for nearly thirty years and yet we find there is sufficient. In Manchester and Liverpool a very considerable expense has had to be incurred in increasing the supply; and in Birmingham, although the population to be supplied is not more than 600,000, and already supplied with water, it is proposed to spend between five and six millions sterling upon new works. I must also congratulate the Corporation of Dublin upon the engineering capacity and skill which has been shown in carrying out the undertaking. It is very interesting to hear of the method adopted here of cleansing the filters. I have not heard before of a similar thing being done. Mr. Harty perhaps will tell us whether he found the sand itself to the depth of two feet contained impurities, because I generally understood in a carefully constructed filter the sand arrests the objectionable matter in suspension. What we saw yesterday apparently proves that it is not so in this instance, and the experience gained here will be of use to the members of the Association. It would also be interesting if Mr. Harty could give us the depth of rain which falls over the watershed area, and the quantity which is available for supply. If Mr. Harty could give us that information I, for one, shall be very thankful. There is one very important point raised here as to the prevention of waste. Many people contend that it is impossible to prevent waste of water without waste water-meters, and other expensive arrangements. Mr. Harty tells us there has been no necessity to use waste water-meters here. That is very satisfactory; but, on the other hand, we must remember that Dublin has been supplying an abnormal quantity of water per head of the population. In other cities, where it has been necessary to restrict the supply, the quantity used has been reduced from 50 gallons per head to 20 gallons by means of waste water or other meters. However, so much the better for Dublin when water to a great extent is wanted, for it shows that the present scheme will last a considerable time.

I daresay the attention of many gentlemen has been attracted by the remark that snow falling upon the ground over the water pipes has immediately melted. That is given as due to the friction caused by the velocity with which the water passes through the pipes. I would like to ask Mr. Harty if he is satisfied that that is so; I would rather take it to be due to the higher temperature of the water itself. If it is not so, but is really due to the friction, it would be interesting to know what the friction is that produces such an extraordinary result.

I will only make one allusion to the remaining portion of the paper—the maintenance of roads and repairs of roads in Dublin. Mr. Harty says that some of the macadam roads require to be remade every year. That must be an expensive mode of road-making. It shows very clearly to my mind that some other system should be adopted. I have always held that where a macadam road will last two years it is the most economical road to have, but where it will not last two years it is well to substitute a granite sett paved road.

With reference to Mr. Dorman's paper, that also is one of great instruction to us, and I am sure we shall all read it with the greatest possible pleasure. Again I express my grateful thanks to both gentlemen (Mr. Harty and Mr. Dorman) for the treat we have had on this the first visit of our Association to Dublin.

Mr. Lynam, County Louth: I think I can answer Mr. Pritchard's question as to the rise in temperature caused by the velocity of the flow of water through the pipes. If a head of 772 feet of water is expended in friction it will give an increase of one degree, and with 330 feet of water, as in Dublin, you would have a rise of three-sevenths of a degree nearly. The high temperatures of the main from Callow Hill to Stillorgan is probably due to spring water from Callow Hill tunnel. The maintenance of county roads, which is dealt with in Mr. Dorman's paper, is one of the chief works of county surveyors in Ireland, and the question is what amount of supervision those works require from the county surveyor. In many counties the Grand Juries have cut down salaries and refuse assistants, and the consequence is that through a great part of Ireland the county surveyor does not see his roads even twice a year. In those circumstances it is not worth while for the surveyor to specify a measured quantity of material because it would be removed soon after inspection. In the county of Louth, which I represent, this matter of road inspection is on a satisfactory footing. The county is a small one, and the surveyor can see all his roads at least twice a year, and the important roads once in every two months. Every barony in the county has an assistant, and each assistant is bound by an agreement to see his roads a certain number of times during the year. The roads are divided into first, second, and third class, and the assistant sees the first class roads once a month, the second class once in two months, and the third class once in three months. In addition to that, there is the county surveyor's inspection, so that there is ample supervision of the roads. There is a measured quantity of material yearly on every road in the county. The material is delivered before the 1st of October, and the assistants have to complete their measurements within six weeks from that date. The material is all spread before the 1st of March, and if any material is required on the roads during the summer months the contractors are bound to supply it at their own cost. All this supervision is expensive, but at the same time it secures good results; and a proof of that is that at every adjourned Sessions where contracts are set, the tenders do not cut down the amount allowed more than 5 per cent. There is no such thing as a man taking a 100*l.* contract for 50*l.*, and scheming and dodging to do 40*l.* worth of work, and put 10*l.* in his pocket. I venture to say that the ratepayers and Grand Jury of Louth get value for their money. Their third class roads are inspected five times in the year, and the first class roads eighteen times a year; so there is no probability of a road falling into neglect, and a contractor not doing his work. The salaries of the surveyor and assistant surveyors amount to 6 per cent. on the expenditure. Now I think 6 per cent. is not an excessive amount for supervision. Some of the counties in Ireland have over 2000 miles of roads; in Louth we have 600 miles, and, seeing the supervision includes all travelling expenses, I think even if the cost were to reach 7 per cent. it would not be excessive. In a county to which I was appointed surveyor some years ago, there was only one assistant, with 1300 miles of roads. The travelling expenses were so high that I must admit I did not see some of the roads twice a year. I drew the line at 100*l.* a year for travelling expenses, and let the other roads take their chance. I did the work thoroughly the first year at a cost of 130*l.* for travelling expenses; but afterwards I did 100*l.* worth of travelling, and left the other 30*l.* worth of work undone. Now, as a consequence of that mode of working, there were no measurements taken of the quantity of material used in that county. The county surveyor drove over the roads once or twice a year, and certified that the roads were in fair order, but no human being could form a close estimate of the amount of work done from such inspections. Those 1300 miles of road were maintained at a cost of 12,000*l.* In that county the ratepayers tried to do things cheaply and well. Their supervision cost them only 4 per cent., but while they saved, perhaps, 3 per cent. on supervision, I have no hesitation in saying they may have lost 40 per cent. on work. I think the question ought to be ventilated and made public, that a saving of 2 per cent on supervision may be a mistake on the part of the ratepayers. The remedy is in their own hands: they require no Act of Parliament, for they can provide assistants to do the work properly if they only think well to do so.

Mr. COWAN, County Down: I should like to ask Mr. Harty if he has yet started a series of observations as to how often he should cleanse his filters to the bottom. With reference to the paper by Mr. Dorman on road maintenance, I think his chief fault is that he is too modest. Irishmen are proverbially too modest. I claim that the Irish system for county work is twenty years ahead of the Scotch and English systems. We already have in the Irish system the main points sought in the recent legislation for Great Britain. We have open district courts at which all taxpayers may attend, and each man can express his opinion and be listened to. Those opinions go before a Second House, the Grand Jury, who have no power of initiative, but can only vote upon the estimates passed by the first Court. After those Courts we have the Judge of assize, sitting at the same time as the Grand Jury, and he can be appealed to with respect to any vote or estimate, or any complaint on the part of taxpayers. We therefore have what you are anxious to obtain in England—District

Councils, which meet in the ordinary course twice a year. We have a surveyor appointed by the Lord Lieutenant after competitive examination, and inquiry conducted by the Civil Service Commission. They are not likely therefore to be biased in any way by any one wanting a "job." Nobody can be paid without a certificate from the surveyor, and he is a very foolish man if he signs anything which ought not to be signed. Mr. Dorman says that contractors only receive payments twice in the year. That may be so in many counties, but it is not true of all parts of Ireland. With regard to County Down, I have there the freest hand in regard to payments, and make frequent advance payments on contracts which exceed 20*l*. in amount. This matter of payments, however, depends much more upon those that are carrying out the law than upon the law itself. Clause 4 of Mr. Dorman's paper is very true and very important, as we require greater facilities for the purchase of rollers. In Clause 5 Mr. Dorman says "the cost of erecting each mile-stone, direction-post, or stone depot for material shall not exceed 1*l*." That is so, but by presenting for walls at the same time we can get any amount of money required. Mr. Dorman says he is "satisfied no system can compare with the contract system as adopted in Ireland on the score of economy." That is true in a county where you have a large number of contractors, where you have a healthy competition from a number of good men, and where the roads are light, but in a county where you have a few small farmers to take contracts, the surveyor can do the work far better and cheaper himself, especially on roads with heavy traffic. I wish to impress once more these facts upon you: We have a District Council system; we have what is practically a County Council, not initiating, but supervising the contracts; and we have central control by an independent officer, who is responsible for all roads, and who takes all the blame—and there is plenty of it—whenever anything goes wrong in any part of the county.

Mr. Richards: I have listened with great interest to the paper read by Mr. R. H. Dorman upon the question of road maintenance. The author speaks of the necessity of accepting the lowest tender for any work. I think it is a very grave objection in any kind of work that the surveyors should be compelled to accept the lowest tender. If that is compulsory the result is that you often get the worst work. Mr. Dorman says he is "satisfied no system can compare with the contract system as adopted in Ireland on the score of economy." I can only say that if the contract system in Ireland is the same as in England I do not agree with him. I have found that it is more economical and more satisfactory to do the work by your own men than to do it by contract, because you buy the material and you have no interest in putting less on the roads than you specify or want; whereas the contractor has an interest in putting as little material as he can on the roads and if you do not look after him he does not put it on as often as he should, and the roads go down. The question of broken stone has cropped up in my own district in a very curious manner. I do not know whether Mr. Dorman has any clause in his specification as to a two-inch ring. In the London specifications, and, I believe, generally in England, we have such a clause. This diagram is intended to show the difference between a two-inch cube and a cube which will pass through a two-inch ring. In some of the districts round London the specification says that every stone shall be cubical, and that it shall be broken to such a size in its greatest dimension as to pass through a two-inch ring. That means, practically, a stone of the size of one inch and an eighth. It is not customary, I believe, to ever insist upon that requirement being literally fulfilled, and I do not know that you could get stone so broken if you wanted it. A member of my Board has said to me, "Why don't you insist upon having the specification carried out? By not doing so you are defranding the ratepayers, because a ton of stone if it is of this size will only cover so many square yards, whereas if it was broken to an inch and an eighth it would cover a great many more yards. You say, 'I should not like to use such a thin coating as an inch and an eighth.' The question then arises, 'Why do you put it in the specification?'" And that is the question to which I wish to direct your attention. This matter is coming on for discussion at the next meeting of the Mortlake District Highway Board, and I venture to think it is a matter of importance to every surveyor in the United Kingdom, because if specifications are to be interpreted in that way, we shall have to seriously consider whether it is advisable to keep such a clause in our specifications. I trust that, in the interests of the members of this Association, the President and Council will take the matter into consideration at their next meeting with a view to devising such a specification as will not only ensure the delivery of proper material under the contract, but will also protect the surveyor from technical criticism of the kind I have referred to.

Mr. F. Griffith, Water Engineer, Leicester: I am glad that I had the pleasure of accompanying the municipal and county engineers to inspect the excellent waterworks of Dublin at Roundwood.

With reference to the cleansing of filter-beds, I have found it necessary to wash the surface sand to the depth of about ¾ of an inch over all the beds about once a fortnight, and the sand in each bed is washed through to the shot once in three years. As a rule the sand washers are situated in the centre of the filter-beds and the sand is washed until the whole discoloration is removed. We have eleven filter beds, containing an area of about 2½ acres, the rate of filtration is from 350 to 400 gallons per square yard per 24 hours.

The consumption of water for all purposes was 27 gallons per head per day in 1879, and by constant inspection and insisting upon the use of superior fittings, the consumption has been gradually reduced to 17½ gallons per head per day of the population supplied with water. The average consumption for the year 1890 was 18 gallons per head per day.

The consumption for trade purposes averages about 5½ gallons per head per day, so that at the present time the consumption of water for domestic purposes is about 12 gallons per head per day.

The waste has been reduced by a thorough system of night and day inspection, and by insisting upon the use of water fittings of the best quality. No meter has been used in the reduction of waste. The results arrived at have been attained by the use of the stethescope, which is applied to the stop valves controlling each district under inspection. Practically the same amount of inspection is necessary in districts where waste meters are in use as where they are not used. Therefore, I have come to the conclusion that waste water-meters are not necessary in controlling a constant supply of water to a town, and I am justified in that opinion from the results of the work done at Leicester. Further, the use of waste water-meters in a large town means the expenditure of a large amount of money, which I consider to be unnecessary. In many cases by use of the stethescope waste has been detected in mains and services underground in public streets and private property, as well as in water fittings.

Mr. Robinson, County of Hampshire: As representing an English county I should not like the opportunity to go by without saying what pleasure it has afforded me to meet our Irish brethren. Time will not permit me to enter into a comparative statement of the two systems in work in England and in Ireland. One thing only I will say: we hear much of Ireland as a place almost to be avoided in some respects; but it seems to me to be a paradise for one class of men—the Irish county surveyors. We in England have quarterly meetings; and gentlemen in boroughs have much more frequent meetings and we both have also numerous committee meetings. But here the surveyors appear to have no committees or anything to bother them, and can deal with their roads in any manner they like, and at a very small expense for travelling. It has been a great pleasure and a help to us to have an interchange of opinions with the Irish county surveyors.

Mr. W. H. Simpson: One of the greatest difficulties and drawbacks a county surveyor has to contend with in England is this, that in years gone by any person, whether he had practical experience or not, was appointed a surveyor of roads. I have 70 miles of main roads and 330 miles of district roads to supervise. It is impossible to get over a large area like that more than two or three times a year, and in my district I do not think it is necessary to do more than that. With reference to specifications for granite, I think it is better not to put in any clause as to the size of the stone, but to buy stone of whatever size you require. In my own district I have put on stone of the size of eight inches. I have had to do this, because it has been necessary to pitch many of the roads, as I have found the centre was in some cases 15 inches below the sides of the roads. By raising the centre of the road with a cross-fall of 1 in 20 you get the water off and obtain a perfect road. We use a steam roller on all roads, and after coating them well with stone, put on a binding material. The average costs of main roads in England is 100*l.* a mile and of district roads 20*l.* or 21*l.* The actual cost of my district roads is about 27*l.* a mile.

Mr. Moynan, County Tipperary (North): From the remarks which fell from the County Surveyor of Hampshire, he seems to be under a mistaken impression as to our duties. We have to meet our various boards and committees twice a year. In my own county of North Tipperary there are six baronies. There are special Sessions for each barony, and a month after the Sessions we meet again. In addition to that we have the two Sessions for the county at large, so that makes in all fourteen meetings. Then there are the meetings of the Grand Jury. At the presentment of the Grand Jury all the contractors who deserve to get their money have their work certified by the surveyor and are paid. Whatever new works are required also go before the Grand Jury, who have no power to initiate new work themselves, but approve or disapprove of the work passed at the Sessions. There are several remedies against defaulting contractors, and providing against any difficulty which might be caused if the Sessions refused to carry out necessary work. To provide against any difficulty that may be caused by work not being contracted for at the Sessions, under the 22nd sect. of 22 Vict. the Grand Jury have power to give the carrying out of those works into the hands of the county surveyor. Second, under the 54th sect. of the Act, if a contractor fails to carry out his contract you can serve a ten days' notice upon him, and if at the end of the ten days he still neglects to do the work, the surveyor employs a man who does the work at the cost of the contractor. Third, you have a power to sue for compensation at the Sessions. The plaint being to the Queen, and not to any authority in the county, the Attorney-General orders a prosecution, and the contractor is sued for an amount which is levied by the Sheriff. The fourth remedy is that the county surveyor can summon the contractor at Petty Sessions, and get an order from the magistrates. If the work is not done in a certain time the surveyor can distrain under the order which has been made by the magistrates, and put the money which is recovered on the roads. This puts on the surveyor the very unpleasant duty of going round with the bailiff and pointing out the goods and chattels which he can seize. There are 51,221 miles of roads in Ireland, in the Grand Jury districts, the total cost of which comes to 12*l.* 7*s.* per mile, that being 1*s.* in the pound on the rateable value.

Mr. Eayrs: I rise simply to second the vote of thanks proposed by Mr. Pritchard to the readers of the papers.

Mr. A. T. Davis, County of Shropshire: As an English county surveyor I should like to say with what pleasure I have come to Ireland, and how pleased I have been to meet the Irish county surveyors. There is, unfortunately, no time to enter into a discussion or to describe our system of road maintenance in England. Of course we English county surveyors came here primarily to learn what the Irish system is. One of the earlier speakers, the surveyor of an Irish county, claimed that the Irish system was some twenty years in advance of the English. I have no doubt in many respects he is right. We are in a transition stage in England.

We have only just had our County Councils formed under the legislation of 1888, and each county has adopted a different scheme. Presently, by meeting together by means of this Association, we shall be able to compare notes, and, I hope, adopt a more uniform system in England. It seems to me that one of the evils of the Irish system is that of repairing by contract. I am averse to the contract system of repair entirely, and I think I am speaking for the majority of the English county surveyors in saying that in our opinion it is not a good plan. I am much obliged to Mr. Dorman for the excellent paper he has given us on road maintenance in Ireland.

Mr. Marks: There is one question I should like to ask Mr. Harty, that is with respect to the prices he gives in his paper. He gives the cost of a street recently paved as 11*d.* per square yard. I do not understand whether that is labour simply in the grouting or for the whole of the work.

Mr. Harty: Simply grouting.

Mr. Duffin (Waterford County): As the time is flying I shall not detain you more than one minute. I must first of all add my thanks to those which have been given to the readers of both papers. I will just say one thing: I agree with Mr. Davis in his remark that the contract system is not a desirable system. I think it is one of the great blots on the Irish system of road maintenance, and my experience does not tally with that of Mr. Dorman, that it is best on the score of economy. I find I am able to maintain my roads at a price at which no contractor will take them, and to keep them in better order than a contractor ever kept them in.

Mr. Whyte: I wish to endorse what both gentlemen (Mr. Davis and Mr. Duffin) have said as to the contract system. I think it may be the best for district roads, but as to main roads it is practically a failure.

The President, in closing the discussion, said: I had a few remarks to make on both the admirable papers we have had read, but time is too short, and I will defer any remarks of my own.

The vote of thanks to Mr. Harty and Mr. Dorman was then put and accorded with acclamation.

Mr. Harty, in acknowledging the vote of thanks and replying on the discussion, said: Mr. Pritchard seems to think the sand should arrest all the impurities in the water. The Vartry water is very peaty water, and as the reservoir gets low and storms arise, the water gets turbid. We have a good deal of difficulty in the filtration process. After we take off a certain portion of the sand for washing and set that filter again to work, the sand remaining gradually becomes more and more impure. I am not able to give Mr. Pritchard the quantity of rain that is lost by evaporation. We have no gauges on the upper part of the river. Sometimes the flood water comes down rapidly after rain; other times it comes down more slowly. With regard to the remark I made about snow melting on the pipes, Mr. Pritchard seems to think, and probably he is correct, that the higher temperature of the water in the pipes may have something to do with it. But I have other pipes where the velocity is not so great, and the water has frozen and the pipes split, which shows that there is something else at work besides the heat of the water. The main pipe has an average of 3 feet of cover. It is a very strange thing that in the fall of the year and in the spring we used to be troubled with a considerable leakage from the joints, caused by the contraction and expansion of the pipes. This occurred at no other season of the year. We have now weeded these pipes out, and have no trouble. I am very happy also to bear out Mr. Griffith, the engineer of the Leicester Waterworks, with reference to waste water-meters. There was much discussion, and an attempt made to bring in waste water-meters for Dublin. I was against it then and I am against it still. I reduced the water consumed in Dublin very materially without any meter at all. What is a meter for? Simply to tell you there is a certain amount of water going into a district; if there is waste the meter will not cure it. You must have men to go into the houses and do the work whether you have a meter or not. In my opinion a waste water-meter is an expensive luxury. With reference to Mr. Pritchard's remark as to the expense of our macadam roads, I may say we do not make each macadam road up every year. Dublin has not been a very prosperous and wealthy city, and consequently some years ago a great many of the macadam streets were neglected; we are now, however, engaged in bringing them up to their proper formation. Once brought up we shall not have to re-make the roads more than once every two or three years.

Mr. Dorman, in acknowledgment, said: I am very much obliged to you for the vote of thanks you have been good enough to accord me. I do not think there is much for me to reply to, as I agree with the remarks made by the majority of the speakers. I hoped to have given you a much better paper, and a more theoretical one, but, after all, an ounce of practice is worth a ton of theory.

A hearty vote of thanks having been accorded to the Lord Mayor and Corporation of Dublin for allowing the use of the Council Chamber for the meeting of the Association, the proceedings in the City Hall terminated.

CORRESPONDENCE.

Mr. James Barber (Streatham): I have charge of 30 miles of roads in this part of the Metropolis, some macadam roads, with a very considerable amount of traffic of all kinds over them; these are repaired with the hardest kinds of broken granite (Guernsey, &c.), at a cost of 1200*l.* per mile per annum; others are repaired with broken flints and gravel at a cost varying from 300*l.* downwards.

These roads were never favoured with the use of a roller until 25 years ago I introduced one of Amies and Burford's 5-ton water-ballast rollers, drawn by four horses, this was used upon all the roads, whatever the kind of material, and the improvement, comfort, and saving effected thereby were highly appreciated.

Some years later the use of a steam roller weighing 15 tons was introduced in some parts of the Metropolis, and in other places, but not without doing some damage to gas and water pipes, &c. I continued the use of the 5-ton horse-roller, deeming the 15-ton roller too heavy for general use upon roads of all classes, but, when I saw the 10-ton steam-roller by Aveling and Porter I soon arranged for its use, first on my main roads, then on the second and third class roads, and afterwards in the making up and paving of new roads for adoption by the parish, and so perfectly satisfied am I with the superiority of the work it does, over that done by the scratching of horses' feet, and at a much less cost, that I am content to allow the 5-ton horse-roller entire rest, while the 10-ton steam rollers (I sometimes use two) do all the work upon every kind of road, whether the material used be hard or soft.

On Friday the 25th, the members assembled at Harcourt Street Station, and proceeded in saloon carriages to Bray. Taking cars the members had a long drive through one of the most picturesque parts of County Wicklow to the City of Dublin Waterworks at Roundwood. The route taken was through Sir Robert Hodson's demesne, "Hollybrook," the village of Kilmacanogue, the Glen of *the Downs, then passing by the side of the Sugar Loaf Mountain, Kilpedder, and Newtownmount Kennedy. The first halt was made at the measuring weir at Callow Hill, through which the entire water supply of Dublin flows, and where the tunnel through which the water passes from the filtering beds at Vartry, a distance of* 4346 *yards, ends. Mr. Harty, the City Engineer of Dublin, acted as cicerone to the party, and answered questions as to the construction of the tunnel and works, which are minutely explained in the exhaustive paper read by that gentleman at the Saturday's meeting of the Association. The party resumed the journey to Vartry, where, on arrival, luncheon was served. After luncheon, the works, filter beds, and reservoirs were inspected. Special interest was taken in the working of the machinery for washing the sand, gravel, and stones used for the purpose of filtration, and in the cleansing of the filter beds, Mr. Harty's method of working being warmly commended by the members. The members left Vartry at four o'clock, and returned to Bray by way of the Rocky Valley.*

In the evening the members of the Association attending the meeting dined together at the Hibernia Hotel.

On Saturday, the 26*th of September, the members, on leaving the City Hall, paid a brief visit to Dublin Castle, the official seat of government in Ireland, and were photographed in the grounds of the castle by Mr. Lawrence. The party then proceeded to Guinness's Brewery, St. James's Gate. On arriving the members were received by Mr. Dunbar Barton, Q.C., Mr. Samuel Geoghegan, Chief Mechanical Engineer, and Mr. W. Westley Wilson, C.E., and each one was presented with a short descriptive history of the brewery. The party was divided into sections each of which was conducted through the colossal establishment by one of the staff, who very lucidly explained the nature of the machinery and the mode of working. The members were taken over the engine rooms, mill room, refrigerating rooms, fermenting tuns, racking sheds, germinating floors, and store rooms, and were treated to a journey on the miniature railways, the ride on which, under arches, through tunnels, and round sharp gradients, formed a sensational experience.*

Before leaving the brewery the members were entertained with light refreshments.

A cordial vote of thanks to Messrs. Guinness was carried with acclamation.

The members then proceeded to the distillery of John Power and Son in John's Lane. On their arrival the members were entertained to a most recherché luncheon. After luncheon, the members proceeded into the distillery yard, where they were shown the admirable and complete arrangements made by the firm for coping with fire. An alarm was given, and the men turned out, fitted on the hose, climbed to the roofs, and had a stream of water drenching the roofs of the buildings within two minutes. The members then inspected the works, which are amongst the largest of the Irish distilleries, going over the grinding and crushing mills, the engine rooms, the brewhouse, the sampling rooms, the spirit vats, and storage cellars.

A cordial vote of thanks to Messrs. Power was accorded with acclamation.

The formal visit to the Port and Dock Works at North Wall had to be abandoned in consequence of the lateness of the hour, but a number of members made an informal visit, and were much pleased with the works.

In the evening the members of the Association, by the invitation of the Lord Mayor, dined at the Mansion House.

VISIT TO THE ELECTRICAL EXHIBITION AT THE CRYSTAL PALACE, SYDENHAM.

On Friday, March 11th, 1892, the members paid a visit to the Electric Exhibition at the Crystal Palace, and under the guidance of Mr. Carr, the Engineer of the Crystal Palace Company, inspected the many interesting exhibits in electrical science.

DISTRICT MEETING AT KENSINGTON.

March 12th, 1892.

Held at the Town Hall, Kensington.

Mr. T. De Courcy Meade, President, *in the Chair.*

The Hon. and Rev. Carr Glyn, the Chairman of the Vestry, said: Gentlemen, I feel myself very fortunate in being allowed, as the Chairman of the Vestry in whose Council Chamber we are assembled, to have the privilege of welcoming to Kensington the Association of Municipal and County Engineers. I believe this is the first part of London that has been visited officially by this Association, although almost every town in Great Britain has had the privilege of a visit from your Association. I should like to say the Kensington Vestry feel very confident in welcoming you here to-day, because we have so high an opinion of our own surveyor, and the work which has been carried on for this parish by Mr. Weaver. We have nothing to hide, and we are only glad of an inspection of the sanitary and engineering works in this parish. Of course recent improvements and recent Acts of Parliament have tried to a great extent a great parish like this, and if your visit had been held a year or two in future—and perhaps you will be good enough to repeat it—you will see this parish is forward in carrying out the new Acts, which we are trying our best to put into work so far as the organisation of this large and important district of London is concerned. I think I may say as an official member of the vestry, who, if I may use the expression, is ornamental rather than useful, that the committee of works and Mr. Weaver are doing their very utmost to put themselves in the very front of the improvements which affect this great metropolis. I believe you will have an opportunity of going round the parish and seeing some of our "lions." I hope the climate, which has not favoured us very much of late, will smile upon you for the rest of the day, as it has begun so pleasantly, and that you will have in Kensington a pleasant day to look back upon in the future, and that you will consider what we are trying to do in this parish is in accordance with the wishes and wants of your Association. I wish not only to welcome this Association but to say, as a ratepayer, what an immense amount of interest is taken now by the ratepayers of London in the work which your Association has at heart, and if you will help forward in England generally, and in London particularly, the good works for which your Association has been founded, I am quite sure that you will find a very hearty public opinion at your backs, and that you will find the intelligent people of England are all anxious to carry out in the very best possible way the objects of the Association which you represent here to-day. I will now, having performed this duty very faultily—a duty which has fallen very often to the Mayors of those towns where you have been—I will now, as the Chairman of the Vestry, wish you in the name of the Vestry, and of the inhabitants of Kensington, a very hearty welcome to this Royal Borough.

The President, who was received with applause on taking the chair, said: Gentlemen, before we commence our proceedings I will ask you to thank the Hon. and Rev. Carr Glyn, the vicar of this parish, and the Chairman of the Vestry, for the kind way in which he has welcomed us to Kensington. This is our first district meeting in the Metropolis, although we have had many annual meetings in London. I am sure we shall learn a great deal from our visit to this important parish. We all feel grateful for the words of encouragement we have heard from the Chairman of this Vestry with reference to the work we are endeavouring to carry out, and his words will be an encouragement to each of us to further the good object we have in view, viz. the advancement of sanitation and improvement of public health.

Mr. O. C. Robson (Willesden), Honorary Secretary for the Home Counties District, then read the minutes of the last Home

Counties District Meeting, held at Hastings, which were confirmed and signed.

Mr. C. Jones, Honorary Secretary, said: I think the next business is the nomination of an Honorary Secretary for the Home District for the ensuing year. I have much pleasure in nominating Mr. O. C. Robson, of Willesden, who has so well performed the duties of the office hitherto, and I think we have much reason to congratulate ourselves in having a man who is so earnest in the work as Mr. Robson. This was seconded and carried.

The following paper was then read and discussed: —

KENSINGTON.

By WILLIAM WEAVER, M. Inst. C.E., Surveyor.

Introductory Remarks.

In offering a hearty welcome to the members of the Incorporated Association of Municipal and County Engineers and Surveyors, the author desires to express his appreciation of the honour conferred by the Association, in selecting Kensington for the first visit of the Association, since the incorporation into its ranks of the engineers and surveyors having charge of the work of the Metropolitan Vestries and District Boards, outside the area of the City of London.

Although the words "Vestry" and "Parish" have not quite a nineteenth-century sound, having about them, as it were, an aroma of church and out-door relief, yet under those unattractive names the local affairs of some 5,000,000 of people have been conducted, and on the whole well conducted, for nearly 40 years past. If the proposed District Councils maintain in the future the rate of progress and improvement achieved in the past by their parochial predecessors, the Metropolis, 50 years hence, will be a place preeminently adapted to live *in*, provided the evolution of the present fermenting social problems, leaves to the individual, sufficient to live *on*.

In no district of London has time wrought more change and improvement than in Kensington. Glancing back to its earliest known history, in Domesday Book, date 1086, the population is recorded as about 200. Coming to more recent times, Kensington through its more celebrated residents, has always left its mark on history; members of royalty, statesmen, names familiar as household words in the ranks of science, art, and literature, appear among its past and present residents. Doubtless a considerable proportion of the popularity of Kensington is attributable to its proximity to Kensington Gardens and Hyde Park, and to the many public buildings in the district.

The parish of St. Mary Abbotts, Kensington, is 2245 acres in area, and extends from Brompton Road by Sloane Street in the south, to Harrow Road near Willesden Junction in the north. It returns two members to Parliament, five members to the London School Board, and four members to the London County Council. The local affairs are administered by the Vestry, consisting of 120 members (a third retiring annually), and a Board of Guardians, consisting of 18 members and (*ex officio*) the Justices of the Peace for the County, resident in the parish.

STATISTICS.

The following table shows the growth of population in Kensington during the present century. There is good reason to believe that the last census return is not correct, and that 180,000 is nearer the mark than the 166,322 officially returned.

The population

in 1801	was 8,556	in 1861	was 70,092
1821	14,428	1871	120,299
1841	26,834	1881	162,924
1851	44,046	1891	166,322

The subjoined table gives the death rate of Kensington during the past 11 years, comparing same with the returns for the whole of England and Wales.

	Kensington.	London.	England and Wales.
1890	16·1	20·3	19·2
1889	13·5	17·4	17·9
1888	15·9	18·5	17·8
1887	16·4	19·6	18·8
1886	15·9	19·9	19·3
1885	16·1	19·8	19·0
1884	15·1	20·4	19·5
1883	15·5	20·5	19·5
1882	16·2	21·3	19·6
1881	16·6	21·3	18·9
1880	17·8	21·7	20·5

As information interesting for purposes of comparison, the following extract from the last annual report of Dr. Dudfield, Medical Officer of Health, is inserted :—

"The death rate in the twenty-seven cities and boroughs next in importance to London, and having a population exceeding 5,000,000, was 21·7, ranging from 16·5 in Nottingham, 17·8 in Brighton, and 17·9 in Leicester, to 25·8 in Bolton, 25·9 in Newcastle, 27·4 in Preston, and 30·6 in Manchester, without correction for differences between one town and another in regard to the age and sex distribution of their respective populations. The death rates of Edinburgh, Glasgow, and Dublin were 20·0, 25·3 and 26·4 respectively."

"In twenty-two of the largest European cities, having an estimated population of about eleven and a half millions, the mean rate of mortality was 25·3 per 1000, and exceeded by 5·0 the mean rate in the twenty-eight largest English towns, including London, having an aggregate population approaching ten millions. The lowest rates were, Stockholm 19·6, Christiania 21·1, Brussels 21·5, Copenhagen and Berlin 21·6; ranging upwards to 29·3 at Venice, 30 at Munich, 31·4 at Buda-Pesth, and 40·3 at Moscow. The rate in Rome was 23·4, in Paris 24·5, in Vienna 24·6, and in St. Petersburg 28·4. In the American cities the general death rate from all causes ranged from 18·7 in St. Louis, to 28·5 in New Orleans. At Cairo it was 44·8, and at Alexandria, 39·6 per 1000. In Bombay the rate was 26·6, in Calcutta, 28·5, and in Madras 42·9."

The rateable value of property in the parish in April 1891 was 2,012,843*l*. A penny rate raises about 7700*l*., and the rates for the year ending Lady Day 1891 amounted to 5*s*. 1¼*d*. in the £; 2*s*. 11*d*. being poor rate raised for the Guardians.

SEWERAGE AND DRAINAGE.

The whole of Kensington is drained into the Metropolitan main sewers, having their outlet at Barking. The subsidiary local sewers are principally brick-built sewers of varying dimensions. Pipe sewers have not been largely constructed, the Vestry holding the opinion that it is desirable to build sewers of sufficient size to admit workmen for the purposes of cleansing, and to give access to each drain outlet. In former times, when gullies were untrapped and disconnecting chambers to house drains unknown, little or no inconvenience arose from the air space in the sewers. Upon the introduction of the modern system of house sanitation, the trapping of all gullies, and the consequent comparative sealing up of the sewers, complaints as to smells therefrom began to arise, and such complaints have increased in proportion to the extension of drain disconnection. The evil has been met, to a certain extent, by carrying up ventilating pipes, increasing the number of surface ventilators, and the insertion of shutter flaps between branch and main sewers; still the evil remains far from cured, sewer ventilation is still an unsolved problem. With a thorough knowledge of everything which has been tried in this connection, the author is of opinion that the common sense and radical cure for sewer smells is for each house drain to act as a ventilator; syphon traps in the main flow of the drains should not be allowed. Drains and sewers should be treated as one system, and the former should aid the latter in their functions, so that the common good of the community should be advanced, not retarded, by the act of the individual. Much could be said on this important subject of sewer ventilation, but the limits of this paper preclude exhaustive treatment. The author has dealt more fully with the matter in a paper read before the Society of Medical Officers on the 20th of February, 1885.

The total cost of sewers built by the Vestry, and estimated cost of sewers constructed by private owners, from 1856 to March 1891, together amount to 98,966*l.* 9*s.* 4*d.*

With regard to house drains, the Vestry require each house to be drained separately to the front. In some exceptional cases combined drainage is permitted, under a special sanction, framed so as to protect the Vestry from having in the future to maintain such combined drain as a sewer. Before any drain work is commenced, plan and notice has to be lodged with the Vestry's Surveyor, and the whole of the work is supervised by his staff, the underground drain being water tested. Four assistants are engaged on this work; between 500 and 600 drains are thus supervised annually. The whole of the drains from sewer to back line of footway are laid by workmen in the direct employ of the Vestry. A copy of the rules as to the construction of house drains is attached to this paper, Appendix A.

Roads.

There are 82½ miles of roads under the charge of the Vestry (March 1891). About 10 miles are paved with wood, the remainder being macadam, flint, and gravel, a small area only, chiefly mews, being paved with alphalte; the larger number of mews are paved with 4 inch by 4 inch cubes on 6 inches of concrete. The flints used are Kentish clay-pit flints; the gravel is obtained from Cowley. The broken granite is of three descriptions, viz., Blue Guernsey, Quenaste, and Enderby (Leicestershire), and is broken to gauges of 2, 1½ and 1¼ inches; the largest size is utilised on roads with heavy traffic, and the smaller sizes for what may be termed carriage roads; the 1¼ inch being used more especially for patching, crowning, and backing up crossings. Two 10-ton steam rollers are employed for consolidating the road metalling; a 15-ton roller, formerly used for a like purpose, has been taken off road rolling, and is now used in the Depôt as a stationary engine for working a circular saw, cutting wood paving blocks, and timber for wheelwright's work. The stoppage of the 15-ton roller on outside work was ordered, upon the Gas Light and Coke Company obtaining an injunction, restraining the Vestry from using steam rollers to the damage of the Company's mains and services. The Court of Appeal subsequently somewhat modified the injunction, by limiting the liability for damage to mains, &c. *properly laid.* See Gas Light and Coke Company *v.* Vestry of Kensington, L.R. xv. Q.B.D. (C.A.) 1. The present state of the law therefore is, that every authority using a steam roller is liable for all damage to mains and pipes, unless it can be proved that the same were not properly laid. The actual cost of repairing a damaged main is of very little moment, compared with the incidental compensation which may arise from a consequent explosion and loss of life. As the result of a Conference of Metropolitan Vestries held at Kensington, the London County Council inserted a clause in their Various Powers Bill, legalising the use of rollers not exceeding 10 tons in weight without liability for damage to mains, if laid at a less depth than 2 feet; the Committee of the House, however, rejected the clause. This result, in the author's opinion, was mainly brought about by the evidence of Sir F. Bramwell, who appeared on behalf of the Gas Company; when asked for his opinion on the clause, Sir F. Bramwell replied "that it was perfectly absurd, as it sought to exempt from liability the only persons who could cause the damage." No attempt was made by the London County Council to refute this evidence, by producing witnesses to testify to fractures prior to steam rollers being used, or to trollies traversing the streets, conveying weights giving double and treble the pressure per inch of tyre as compared with steam rollers. The author has dealt somewhat fully with the subject of steam rolling, as at the present moment every Road Surveyor in the country occupies a very unsafe position. An explosion arising from a fractured gas main may happen any day, causing loss of life and damage to property, involving heavy compensation. If a steam roller has been recently working on the adjacent road, the authority using the roller will only escape liability for the entire consequences by proving that the fractured main was not properly laid, and such proof is extremely difficult of demonstration.

All the main roads, comprising an area of 181,071 square yards, are paved with wood blocks, laid on six inches of Portland cement concrete. Part of this area, to the extent of 79,603 square yards, has been repaved, together making a total area of 260,674 superficial yards of wood paving laid in the district. The particulars and cost of the several works are set forth in Appendix B. The small jobbing and patching repairs are executed by the Vestry's own workmen, and in Appendix C the cost of such reparation is set forth.

Many descriptions of wood, and methods of laying same, have been tried, with the result that at the present time the approved system provides a solid foundation, with 5-inch creosoted deal blocks laid thereon, with $\frac{3}{8}$-inch joint, filled with manufactured asphalt to the depth of half an inch and the remainder of joint filled with Portland cement grout. The blocks are creosoted under pressure, and made to take up at least 10 lbs of creosote to the cubic foot. Every care is taken to secure good wood, unadulterated and natural creosote, and sound workmanship; the details on these points would absorb too much space in this paper, but the author will be happy to supply same on application.

A small trial section of Jarrah wood, from Western Australia, was laid three years ago in Kensington Road, and in October last a further area of about 2500 superficial yards, in Old Brompton Road, was paved with similar wood, 4 inches deep, laid close jointed. In the author's opinion Jarrah promises well as a paving material; it is dense, close grained, hard wood, and owing to its extreme uniformity of quality, wears evenly. It is, however, about double the price of ordinary paving deals, and until it has proved itself by wearing proportionally longer, the author considers it would be imprudent to entirely substitute it for the wood which has furnished such good results in the past.

During the first eight years after the introduction of wood paving into the district, the blocks used were invariably 6 inches deep. Since then 5-inch blocks have always been used, except in Sydney Place and Onslow Square (area 3509 yards), where 4-inch creosoted blocks were laid in 1889. The author's object in reducing the depth of the wood was to save waste of material. Long before 6-inch blocks are worn out, the road has to be repaved, owing to the condition of its surface. So soon as the wood has worn an inch, the three feet of road next kerb is dead level in cross section, and when the wear has increased, the haunch of the road becomes a puddle at every rainfall. With 5-inch blocks instead of 6-inch, the road authority can afford to repave oftener, and thus maintain a better surface for traffic. It is very likely that 4-inch blocks may prove to be sufficiently deep; a trial section in the Old Brompton Road lasted eight years and if the 4-inch blocks in Sydney Place and Onslow Square prove satisfactory, the author will then advise the general adoption of the further reduction of depth from 5 to 4 inches. Each inch reduction of depth represents about one shilling per yard saved, amounting to a considerable sum on a large area of work.

One of the difficulties attached to wood paving is the expansion of the wood, pushing the kerb and paving out of place. To meet this, the author leaves about 1½ inches of margin on each side of road, filling such space with loose oakum, coated over with a film of cement.

The annual charge for first cost and maintenance of wood paving varies of course in different roads according to the amount of traffic. The wood paving laid in Kensington Road in the year 1880, lasted over nine years, and the cost of same, inclusive of repairs, amounted to 1*s.* 6*d.* per square yard per annum. Fulham Road, where the wood lasted nine years, cost 1*s.* 4½*d.* per square yard. In both cases, it must be borne in mind, that no credit is given for the concrete foundation, which remains, as it were, an asset in perpetuity, and therefore the true cost of a wood-paved road can only be furnished after it has been repaved several times, say during forty or fifty years. Scavenging and watering are not included in the above rates of maintenance, and in considering the comparative merits of wood and macadam, it must be borne in mind that the slop from wood paving is much less in quantity, and can be more economically disposed of, than the slop from macadam roads. At the same time, the wood, from the attention which has to be given to its cleanliness, costs more for hand labour than macadam. The conclusion arrived at by the author, after taking into consideration the whole of the facts bearing upon the economy of the question, the comfort of the residents and travellers in vehicles, and the improvement of the district, is to advise his Board wherever a macadam road costs over a shilling a yard superficial for annual maintenance (exclusive of scavenging and watering) to convert it into a wood-paved road.

A most important element of destruction to wood paving is the omnibus traffic, which in the Metropolis is growing to an enormous extent, and as at present conducted, is allowed virtually to govern progression on the main roads. On two of the Kensington roads, omnibuses pass a certain point in each, at the rate of one omnibus every three-quarters of a minute between 7 A.M. and 1 A.M. This species of traffic is most wearing to the wood; the incessant stoppages with skidded wheels and the re-starting, causes great injury. One has only to closely watch the horses attached to a fully laden omnibus making a quick start, and observe the tips of the iron shoes being driven and dug into the wood, to fully appreciate this element of cost to the ratepayers, and to wonder how under such treatment the wood lasts as long as it does.

The author is of opinion that the time has arrived when this question of omnibus traffic should be considered; it entails a heavy expenditure upon the ratepayers, who are not all bus riders, or riders of equal frequency. In many districts tram-car companies pave and maintain the greater portion of the whole width of the roads traversed by their cars; in Kensington the wood paving is laid for the companies, who pretty nearly monopolise the roads, towards which they contribute directly nothing, and indirectly a fractional amount in the general rate, not worth consideration, as nearly all the stables and yards of the omnibus companies are in adjoining parishes, where ground is cheaper, and as an indirect consequence tram lines are more popular.

In concluding this branch of the paper, it may be stated that the roads (other than paved roads) are channelled 16 inches wide, with undressed pitchers 5 inches wide and 7 inches deep, laid on

6 inches of concrete. In some special cases, generally narrow roads, granite tram channels have been laid, but for ordinary purposes the author is in favour of undressed stones; the water by such channels is readily conducted to the gullies, whilst the uneven surface of the stones arrests the road grit and retards the filling up of the gully sand pits, and the formation of deposit in the sewers. It is very much cheaper to pick up the road drift collected in the channels than it is to remove it from gully sand-pits or sewer inverts.

The gullies are constructed from 40 to 50 yards apart; brick sand-pits with flap trapped drains are the most general, but in cases where there is a regular influx of surface water, as in mews, stoneware pan gullies have been fixed. The large iron trapped sand-pits, designed by the author, are fixed in main wood-paved roads, and serve as tanks to receive sludge pushed down by squeegees on wet days.

Footpaths.

With the exception of two small areas, about a mile each in length respectively, paved with asphalte and artificial stone, and a further length of about 3 miles of tar-paved footways, the whole of the Kensington footpaths are paved with Yorkshire flagging 3 inches or 2½ inches thick, edged with 12 inches by 8 inches dressed granite kerb; the latter (during the past ten years) set on concrete. With reference to the respective merits of the various materials used for footway pavements, it is impossible within the limits of this paper to fully discuss them.

The author's opinion is that there is nothing like good hard York, *provided it is good.* Without doubt it is the most comfortable material to walk on, and to the author's mind, the most economical. As a fact bearing on the question of economy it may be mentioned that 3-inch York laid 25 years ago, at a cost of 10*d.* per foot, on the south side of Kensington Broadway, and since that time never repaired, was taken up last autumn; it was then re-faced, re-squared and re-laid in a subsidiary street, at a cost of 3*d.* per square foot; it will last in its present position at least another 25 years, and will then be taken up and the best of it worked up and laid in narrow courses round pleasure gardens, &c.; the residue will be sold partly to builders at 2*d.* or 3*d.* per foot (according to size) for coreing, and the remainder used for road foundation. It will thus be seen that York has several lives, and when in a large district like Kensington several miles of footway have annually to be renewed at a cost of about 2500*l.* per mile, it behoves the Local Authority and its advisers to be careful in selecting the material which gives the best and most economical results, considering the whole cycle of its user. Another point, not to be disregarded, is the adaptability of the material to the incessant and increasing disturbance for gas, water, electric lighting, telegraph and other purposes.

One of the most important duties connected with footpaths is the proper supervision of the construction of vaults thereunder. A very large annual expenditure for relaying channels and resetting curbs may be saved, if at the time of building the vaults the space between the head wall and battered face of excavated ground is filled up with concrete. In Kensington plans for all vaults in all streets, new or old, have to be submitted and approved, and the construction of same carried out in accordance with the rules set forth in Appendix D. In new districts the author would advise that the crown of vaults should be kept down at least 18 inches under paving so as to allow room for laying mains, &c.

In concluding the remarks under this head, it may be stated that the cost of masons' and paviors' work executed in Kensington during the year ending Lady Day 1891, amounted to 10,360*l.* *exclusive* of trench work performed for companies. The total cost of masons' and paviors' work (exclusive as aforesaid) since 1856, amounted to 251,634*l.*

In streets suitable for their growth, 1245 trees, principally planes, have been planted, and are regularly attended to by men on the staff.

Scavenging, Dusting, Carting and Watering.

The whole of these works are performed by the Vestry's own plant and staff, which comprises 100 horses and 2 cobs for superintendent, 19 waggons, 88 carts, 54 water vans and 6 water carts, and the necessary men. The horses cost on an average 75*l.* each, and the cost per week for horse keep during the year ending Lady Day 1891 was 14*s.* 10*d.* per horse. This amount is exclusive of Veterinary Surgeon and drugs, but includes fodder and shoeing. The waggons and carts are made in the Vestry's workshops, where the necessary machinery is fitted up for making the wheels, &c., drilling and bending the tyres, heating and fixing same, &c.

The wheelwrights' machinery is driven by a 7 horse-power gas engine, which also works the chaff-cutter, oat-bruiser, &c. Four wheelwrights and four blacksmiths are constantly engaged in this department and in executing other parish work.

The total cost of the works of scavenging, dusting, carting and watering for the year ending Lady Day 1891, amounted to 41,706*l.* which sum includes instalments of loans and interest.

The Vestry does not separate the accounts for each branch of the work, the author therefore is unable to furnish the cost of each.

For the purposes of road scavenging the parish is divided into 10 districts; 164 scavengers are employed, and there are also 11 horse-brooms and 8 horse road-scrapers used. The main roads are swept during the night, and the carts commence removing the slop at 6 a.m.; the gullies in these roads are also emptied and disinfected in advance of the slop carts. In the winter 6 sand distributors are employed to assist manual spreading, and whenever necessary the roads are sanded at night. The road refuse from the south section of the parish is carted to the wharf at Chelsea and barged away at a cost of 1*s.* 4*d.* per cubic yard. At present the northern road refuse is shot into brickfields, the Vestry paying 1*s.* and 1*s.* 3*d.* for each load shot. The total number of loads of refuse removed from roads and gullies during the past year was 45,458.

To meet the extraordinary work of snow-falls, four snow-ploughs (horse) are provided, and the author has also made a plough to be driven in front of a steam roller; it has only been in work this year but so far has proved very successful. To meet the new duty of removing the snow from footpaths, the author has had made to his own design some hundreds of light steel squeegees, each 4 feet wide, fixed obliquely to handle. Two men with these tools are able to clear *lengthwise* an ordinary wide footpath.

In this new duty of snow removal from footpaths, Parliament has increased the difficulties of what heretofore was an almost impossible task. In dealing with a snow-fall, promptitude is the main element of success; it is impossible to clear (as in Kensington) 150 miles of footpath all at once, and the work if attempted after the snow has been down for three or four days, leaves the footpaths more dangerous for traffic than if the snow was left untouched.

Last winter the cost of snow-falls to the Kensington Vestry, without the new duty of footpath clearance, was as under:

		£	s.	d.
40 tons of salt	at 30s.	60	0	0
2924 yards of sand	,, 3s.	438	12	0
2550 horse cart and driver, one day each	,, 11s.	1402	10	0
4230 regular workmen's wages	,,	916	10	0
5521 regular scavengers	,, 3s.	828	3	0
9573 extra men	,, 3s.	1435	19	0
		£5081	14	0

The dust is collected regularly on stated days from each house in the parish; no house is visited less frequently than once a week; from some premises the refuse is removed twice, and others thrice a week, and in some cases (residential flats) the carts call daily. The Vestry would seriously entertain the question of a daily removal throughout the parish, were they armed with power to compel the abolition of dust-bins or dust-holes, and to enforce in lieu thereof the provision of movable receptacles. Having failed in their endeavours to get the late Metropolitan Board to apply for such powers, and the New Public Health (London) Act moreover sanctioning the continuance of the old insanitary type, the Vestry and its officers consider that it is not advisable to embark upon such work of daily collection. Doubtless the great majority of house-holders could be induced to use, and at stated times put out movable receptacles, but the non-agreement of a small minority would be quite sufficient to put the whole work out of gear.

The collected house refuse, amounting to about 45,000 loads per annum (a load averages 23 cwt.), is barged away on the river Thames to the south of the parish, and the Grand Junction Canal in the north district. For each load shot into barge on river, the Vestry pays 1*s.* 11*d.* per load, and on canal 2*s.* 4*d.* per *ton.* Some 2400 loads have been delivered to the Refuse Disposal Company at Chelsea, the Vestry paying 1*s.* 9*d.* per load.

The Vestry is of opinion that the house and street refuse can be utilised for agricultural and brick-making purposes, and towards this end 18 acres of land has been purchased at Purfleet, abutting on river and rail, and experiments are now being made with the refuse deposited on the land. A committee of the Vestry is now seeking for suitable similar land on the banks of the canal.

It will be seen that the collection and disposal of the house and street refuse of Kensington entails a very large expenditure. Doubtless the work could be done much cheaper; fire would destroy the house refuse at a cost of about 1*s.* a ton with a residue of about $\frac{1}{6}$ to barge away, instead of the whole being barged away as at present, at a cost of about 2*s.* a ton; but it must be borne in mind, that in a district like Kensington, the *cost* of the work *itself* is not the only item to be considered, the effect on the district must be taken into account.

The question of destructor or no destructor was made an election test, and by a considerable majority the proposal to erect a destructor was condemned, and subsequently the utilisation scheme adopted.

The author's reports to the Vestry were in favour of the erection of a destructor for consuming the non-saleable part of the house refuse, and the employment of the waste heat in working machinery, first, for the washing of the refuse from flint and macadam roads, and secondly, for the generation of electricity. Samples of the grit and sand obtainable from the road sweepings are before the meeting; no better material for wood paving, when slippery, can be desired than the sample grit, while the sand is useful for the same purpose, or for road consolidation, or it could be readily sold for 3*s.* 6*d.* per yard.

The author is at the present time paying 4*s.* per yard for sand at Fulham, and has to cart it 2½ miles.

The electric current generated could be used for street lighting or for propelling the dust carts. The latter would effect a saving of about a moiety of the manual labour now employed, and would of course abolish the horses now employed chiefly in standing about with their nose-bags on to keep them quiet.

Nothing need be said under the head of Carting; it is of the ordinary character, and the men engaged in it (as in the other branches of horse work) are paid by the day. The watering of roads is effected by four-wheeled vans, a few carts being employed in hilly districts, and one two-horse van being engaged on the broad roads around the Natural History Museum. There are three Water Companies in the parish, viz.—Grand Junction Company, West Middlesex Water Company, and the Chelsea

Water Works Company; all three Companies take their supplies from the Thames, and their charges for the road watering are as under:

Grand Junction, ¾*d.* per square yard of road surface, less 20 per cent. discount.

West Middlesex, 5*s.* per 100 superficial yards, less 17½ per cent.

Chelsea, 5*s.* per 100 superficial yards, and 30*s.* each standpost.

LIGHTING.

The whole of Kensington is within the area supplied by the Gas Light and Coke Company. There are 4329 public lamps in the streets; of this number 32 are refuge lamps, with 50 or 100-candle power burners. The lamps are lighted on the average meter system, a meter being fixed to about every 20 lamps. The lamps are fixed, lighted, extinguished, cleaned and repaired by the Vestry's staff of 42 lamplighters and 8 supernumeraries, 1 foreman and 4 workmen; the whole being under the direction of Mr. Monson, the Lighting Engineer. The lamp governors are regulated to pass 4·5 cubic feet of gas per hour; the price charged for gas is (Lady Day 1891) 2*s.* 2*d.* per 1000 cubic feet. The cost per lamp was 2*l.* 14*s.* 1*d.* and the lighting rate 1¾*d.* in the 1*l.* The working of the average meter system commenced in 1877, and its economy and advantages over the old system of a fixed annual payment, amounting to 3*l.* 8*s.* 2*d.* per lamp, will be at once seen by taking three years of the old and three years of the new system. In 1873 under the old system, and the burners regulated to consume 3 cubic feet per hour, the lighting rate was 3½*d.* in the 1*l.*; in 1874 it was 3¼*d.*, and in 1875 it was 3¼*d.* In 1887, under the average meter system, the Vestry having the control of the lighting and repairs and paying only for the actual quantity of gas consumed, and the burners regulated to pass 4·5 cubic feet per hour, and giving upwards of 50 per cent. more light, the rate was 1¾*d.* in the 1*l.*; in 1888 it was 2*d.*, in 1889 it was 1½*d.*

Not any of the public street lamps are permanently lighted by electricity, although some of the refuge lamps have been so lighted experimentally.

With regard to the Electric Lighting Act, the author advised the Vestry to apply for a provisional order and go in for the work themselves, a course since adopted by the Vestry of St. Pancras. Looking to the enormous amount which would have to be raised, and the probable discontent of residents in districts outside the first areas lighted, the Vestry deemed it preferable to divide the parish into six areas, which have been allotted to five companies, viz.

London Electric Supply Corporation, Limited.
Notting Hill Electric Lighting Company, Limited.
Kensington and Knightsbridge Electric Lighting Company, Limited.
Chelsea Electricity Supply Company, Limited.
House to House Electric Light Supply Company, Limited.

The last mentioned company undertakes the lighting of two areas.

The system of supply adopted by the whole of the Companies (except the House to House Company) is arranged on the low tension system. The House to House Company's system is an alternating current, transformer high pressure supply, with high pressure service lines from distributing mains, and transformers on consumers' premises, reducing the current to low tension. The provisional order granted to this Company contains a condition, that so soon as the amount of supply in the district appears to warrant it, the Company may be called upon by the Board of Trade to establish distributing stations and lay distributing mains worked at a low pressure.

About 15 miles of roads and footpaths have been opened up for the purpose of laying electric mains in the parish. In some cases the conductors have been laid in brick or concrete culverts; in other places, Callendar bitumen tubes or iron pipes have been used. In laying the mains numerous difficulties have to be surmounted, in fact in some streets it has been a matter of extreme difficulty to find space in which to lay the mains. The author is strongly of opinion that all main roads (at any rate) should have a subway for the reception of mains, &c. If such subway was built simultaneously with the construction, or reconstruction of the sewer, the additional cost would not be great; there would be no extra excavation, the additional cost would be for the brickwork only, plus the necessitated extra surplus earth to remove, and if the excavation was in sand, such surplus earth would form a credit. Stoneware pipes for the reception of the gas and water services and electric wires could be laid from subway to vaults, and if these pipes were laid in the drain trenches, the cost of the stoneware pipes would be the only extra cost beyond subway. The author is of opinion that if the cost of such subway works were defrayed by a loan spread over 50 years, the various Companies could be charged a rent which it would be economical for them to pay, and sufficient to return a profit on the outlay. At the same time the appearence of the roads and footpaths would be vastly improved, and the comfort and safety of the public enhanced. Drawings, Appendix E, show the various methods adopted in laying electric mains in the streets, and drawing, Appendix F, shows a suggested form of subway, with concrete sewer beneath same.

In the works of Scavenging, Dusting, Carting, Watering, and Lighting, about 500 men are employed and paid through the weekly pay sheets; the wages amounted last year to 34,368*l.*, averaging about 660*l.* per week.

Improvements.

Owing to the growth of and changes in the parish, it has been found necessary from time to time to alter, widen, and improve some of the thoroughfares in the parish. The first most important work of this nature was the widening of Kensington High Street, by pulling down the property on the south side opposite the church and rebuilding to the present line. This improvement was effected in 1869 by the Metropolitan Board at a cost of 126,434*l.* Notwithstanding this widening, the traffic of late years has so much increased that a further extension of the widening is absolutely necessary, and the Vestry is now taking active steps to bring about such further improvement.

In 1880 a special Improvement Act was obtained by the Vestry for the widening of Church Street, High Street, Notting Hill, and for the construction of a new bridge over the canal, at the north end of Ladbroke Grove Road, and for the widening of the approaches to such bridge. All these improvements have been effected at a cost of 33,672*l.*

Subsequently a further section of Church Street was widened at a cost of 23,700*l.*

The only improvement of magnitude now in hand is the construction of a bridge to carry the Cromwell Road into Fulham over the West London Railway. For this improvement a Bill has been deposited by the London County Council, for the consideration of the present session of Parliament.

Parochial Buildings, Property, Etc.

For the purposes of its municipal work the Vestry possesses the following properties :—

	£	s.	d.
Town Hall (designed by Mr. R. Walker), cost of site, buildings, and fittings	47,965	13	0
Public Mortuary, in Churchyard, cost of buildings ..	1,798	7	7
Hammersmith Wharf, value of	8,804	6	8
Chelsea Wharf, Lots Road, value of	15,743	15	7
Kensal Road Wharf, value of	21,750	0	0
Purfleet Depôt, value of	6,219	0	0
Warwick Road Stables, value of	9,586	6	4
Pembroke Road Depôt, value of	2,619	0	0
Pottery Lane Depôt, value of	1,000	0	0
Total	£115,486	9	2

The value of the horses, plant, tools, machinery and materials in stock on the 25th March 1891, was 20,781*l.* 12*s.* 3*d.*

In addition to the foregoing buildings essential for the conduct of parochial administration, Public Baths and Washhouses and Free Public Libraries have been erected.

The Baths and Washhouses are situated at the junction of Lancaster Road and Silchester Road, Notting Hill, and were opened in the spring of 1888. The cost of the site was 13,443*l.* 15*s.* 11*d.*, the outlay on buildings amounted to 46,292*l.* 15*s.* 10*d.*, making a total of 59,736*l.* 11*s.* 9*d.*

The Swimming Baths (Tepid) consist of :—

Men's.	Size.	Depth.	Contains galls. of Water.	No. Separate Dressing Compartments.
1st Class	87 ft. by 46½ ft.	3 ft. 7 to 6¼ ft.	126,000	50
2nd Class ..	50 ft. by 31¼ ft.	3 ft. 2 to 5 ft. 7	44,000	35
3rd Class	61 ft. by 24¾ ft.	3 ft. 7 to 5 ft. 7	43,000	52
Women's	61½ ft. by 22½ ft.	3 ft. 2 to 5 ft. 7	40,000	31

The Private Baths consist of:—

	1st Class.	2nd Class.	3rd Class.	Total.
Men's	13	—	34	47
Women's	7	20	—	27
Totals	20	20	34	74

Scale of Charges.

	Men's Tickets.			Women's Tickets.	
	1st Class.	2nd Class.	3rd Class.	1st Class.	2nd Class.
	£ s. d.	£ s. d.	d.	£ s. d.	d.
Cold	0 0 3	—	1	0 0 3	1
Warm	0 0 6	—	2	0 0 6	2
Swimming	0 0 8	0 0 4	2	0 0 8	
10 do.	0 5 0	0 2 6	—	0 5 0	
50 do.	1 0 10	—	—	1 0 10	
100 do. transferable	2 1 8	1 0 10	—	2 1 8	

Liberal arrangements are made for Clubs, Schools, &c.

The Public Washhouses and Laundry.

There are 60 separate washing compartments, with an unlimited supply of hot and cold water, and steam for boiling, steam wringers and mangles, with drying chambers containing 55 horses, and ironing room with stoves, tables, and blankets.

The Public Libraries Act was adopted in June 1887, the rate being limited to ½*d.* in the 1*l.*, and there are now three free public libraries, viz.—at the Vestry Hall, at Ladbroke Grove, and at Clareville Grove, Brompton.

On the erection of the Town Hall, the old Vestry Hall was converted into the present Library and Reading Rooms. The building recently opened in Ladbroke Grove, cost about 4000*l.* for site, and 3800*l.* for erection, exclusive of fittings. The Library in Clareville Grove is conducted in a private house, pending the procuration or erection of suitable premises.

The numbers of volumes in the Libraries are: Vestry Hall 14,887, Ladbroke Grove 8538, and Clareville Grove 4654; total 28,079.

Recreation Ground, Notting Hill.

This ground is four acres in extent, and it was upon this site that the Vestry originally proposed to form a depôt and erect a destructor, but upon that scheme being rejected, as hereinbefore referred to, the land was acquired for the purpose of forming a recreation ground. The cost of the land and works amounted to about 15,000*l.*

Conclusion.

In submitting the foregoing remarks, which the author trusts have not tried the patience of the meeting too much, he would suggest for the consideration of the Metropolitan members of the Association, the desirability of their holding an occasional meeting, for the discussion of matters generally affecting their work; by such means a more uniform system of dealing with Metropolitan work would be arrived at, and good results should accrue both to the members themselves and also to the various districts with which they are officially connected.

APPENDIX A.

Rules as to the Construction of House Drains, &c.

1. All persons proposing to form new, or to reconstruct old house drains, shall give due notice at the office of the Vestry's Surveyor.
2. The notice shall be given on a printed form, to be obtained at the Surveyor's office, and on which shall be drawn a plan of the premises proposed to be drained, to a scale of eleven feet to an inch, with all lines of proposed drains and their branches and inlets shown thereon in red, with the proposed size of the drains, the nature of the inlets, and the depth of the lower floor of the premises below, or its height above (as the case may be), the level of the pavement outside the said premises.
3. Drains should be kept outside the house whenever practicable.
4. The main drains should be of approved glazed stone-ware, laid in a direct line to a point near the surface of the ground in the rear or higher end, where practicable, for the purpose of passing a machine through the main portion in case of stoppage.

5. All drains shall be of the sizes and diameters as ordered by the Vestry. All stone-ware pipes shall have a thickness of at least one-eighth their internal diameter.

6. All junctions of one line of drain pipe with another shall be made at the sides of the pipes, and not at the top, by means of properly formed junction pipes, curved junctions or obtuse angled junctions being in all cases used where practicable, no T or right-angled junctions being allowed, except where absolutely necessary. Taper pipes shall be used where the size of drain is reduced in the general run. Manholes, with channel pipes and movable covers, shall be provided wherever directed by the Surveyor.

7. All drains shall be laid with a fall toward outlet of at least one-and-a-half inches in ten feet. The pipes, exclusive of joints, shall, where directed, be bedded on Portland cement concrete, and after the joints have been examined and the drains tested by Vestry's Surveyor or his assistant, the entire drain, or the collars and joints only, or any part thereof, shall be bedded on and surrounded with concrete to such depth and thickness as he may direct. No drain shall be deemed to have been laid to the satisfaction of the Vestry until it has been tested to the satisfaction of the surveyor or his assistant.

8. The pipes are to be put together with great care, the butt end of one pipe being forced into the socket end of the next pipe as closely as the nature of the pipes will permit, and the ring or space between them shall be filled in with Portland cement of good quality. The cement shall be well and thoroughly worked in, so as to effectually fill the whole of the space, and a band of cement shall be carefully worked round and outside of the pipe to the thickness of the outside of the socket, so as to completely cover the joint. The inside of each pipe as laid shall be carefully cleaned so as to remove any projecting cement.

9. The connection between the house drain and the public sewer and the portion of the drain that is beneath the public way shall be made by the workmen of the Vestry, and the party requiring the drain shall deposit with the Vestry a sum of money to be estimated by the Vestry's Surveyor, to pay the expense of such connection and length of new drain, and any other works in connection therewith; and also the cost of the reinstatement of the public way disturbed by reason of the works.

10. All water-closets in the lower floor of premises, and all surface drains, sinks, gullies, rain-water pipes, and other connections (except vertical soil pipes), shall be well and efficiently trapped by syphon or other approved trap, before being connected with the drains. Wherever practicable, rain-water pipes shall discharge over trapped stoneware gullies.

11. Scullery sinks should discharge into or over properly trapped catch-pits for preventing fat, &c., from passing into drains.

12. No water-closet will be allowed to be formed beneath the public-way.

13. All water-closets in the upper floors are to be trapped before they are connected with the vertical soil pipes, and all soil pipes are to be ventilated from their highest points, by means of pipes of not less than three inches in internal diameter, formed of lead or iron with all joints made air-tight, carried up to above the roof of the premises, and made to discharge into the open air as far as may be reasonably practicable from all windows, doors, chimneys, or other openings.

14. All soil pipes shall, where practicable, be placed outside the buildings, and where formed inside shall be of lead only, and shall not be built in the wall, but shall be fixed in grooves or chases, and be made readily accessible at all times throughout their entire height. All junctions with soil pipes should also be exposed to view, and easily accessible.

15. Drains are to be ventilated to the satisfaction of the Vestry's Surveyor, with special ventilating pipes (in addition to soil pipes as above referred to) if directed, and in the case of new houses, a ventilating pipe is recommended, carried up from the drain on the sewer side of intercepter.

16. No waste-water pipes in the upper floors of premises are to be connected with soil pipes or water-closets, and if connected with rain-water pipes shall only be with such pipes as are outside the buildings, and the junctions shall be made at such points outside the building as shall be easily accessible at all times.

17. The main line of drain before being connected with the public sewers should be trapped outside the house by means of syphon trap, with access chamber thereto constructed in brickwork in cement, and provided with a fresh-air inlet and air-tight cover.

18. All premises shall have good and sufficient water supply, with all necessary supply pipes, services, cisterns, fittings and apparatus for the purposes of the water-closets, separate and independent to that used for drinking, culinary, and household purposes.

19. The overflow or warning pipe of every cistern shall have no direct communication with a soil pipe or drain ; but this regulation shall not be construed to prohibit the provision of an air-tight washer waste for cleansing purposes.

20. Baths, sinks (other than scullery sinks), and fixed wash-basins, should have no direct communication with soil pipe or drains.

21. The whole of the works in connection with the drains shall be executed with the best materials, and in the best and most work-

manlike manner, in accordance with the directions herein set forth, and to the complete satisfaction of the surveyor, inspector, or other officer appointed by the Vestry, and his directions in all matters relating to the work, as to the lines of drains, their depths, sizes, inclinations, mode of trapping, quality of materials or workmanship, shall be abided by. No portion of any drain or works in connection therewith shall be covered in until it has been inspected and approved by such officer of the Vestry, and at least twenty-four hours' notice shall be given at the Surveyor's office, by the person forming the drain, when the works are ready for such officer's inspection; and if any drain is covered in without such notice being given the Vestry will by its own workmen proceed to open up and uncover the said drain, and charge the expense of doing so, and of subsequently making good the same, on the party so neglecting.

22. All old brick and other disused drains shall be broken up and destroyed, and the materials forming them, and all foul and sewage-charged earth and other substances carefully removed from the premises, dry earth, or ballast, or brick rubbish being brought in if necessary in place of them.

23. All old cesspools shall be emptied and their contents carted away, and the cesspools filled in with dry earth, ballast, or brick rubbish, and well consolidated. The upper portions of the wall and materials forming cesspools shall also be removed to a depth of three feet from the surface of the ground, and carted away.

24. Any person objecting to the requirements of the Surveyor, can appeal to the Works, Sanitary, and General Purposes Committee of the Vestry.

APPENDIX B.

STATEMENT OF WOOD PAVEMENT LAID IN KENSINGTON UP TO 25TH MARCH, 1891.

Name of Street.	Position of Paving.	Date when Paved.	Area of Wood Paving.	Cost per Yard.		Terms of Maintenance.	Description of Paving and by whom laid.
			Yards.	s.	d.		
1 Kensington High Street	King Street to Hornton Street	May, 1877	1,714	14	0	3 years free.	6-in. blocks on 6-in. Portland cement concrete, grouted in lime. Messrs. Mowlem & Co.
2 Ditto	King Street to Palace Avenue	May, 1877	4,188$\frac{7}{9}$	14	0	2 years free; 13 years 1s. per yard per annum.	6-in. blocks laid on $\frac{1}{2}$-in. boards on 6-in. Portland cement concrete, asphalt joints. The Improved Wood Pavement Company.
3 Church Street ..	Clarence Mews to Kensington High Street	Aug., 1877	727$\frac{8}{9}$	14	0	2 years free; 10 years 1s. per yard per annum.	6-in. blocks on 6-in. Portland cement concrete, felt laid under blocks and between each row of ditto. Henson's Street Paving Company.
4 Fulham Road ..	Sydney Street to Charles Street	July, 1878	1,587	14	0	3 years free.	6-in. blocks on 6-in. Portland cement concrete, grouted in lime. Messrs. Mowlem & Co.
5 High Street, Notting Hill	Ladbroke Terrace to Palace Gardens	Dec., 1878	7,102$\frac{8}{9}$	12	6	3 years free.	Same as above. Messrs. Nowell and Robson.
6 Brompton Road..	Hooper's Court to Montpelier Street	Dec., 1878	5,960$\frac{2}{3}$	13	9	3 years free.	6-in. blocks on 6-in. Portland cement concrete, with intervening $\frac{1}{2}$-in. layer of asphalt, joints grouted, lower half depth in asphalt, and remainder in Portland cement grout. The Asphaltic Wood Pavement Company.
7 Ditto	Montpelier Street to "Bell and Horns" Public House	Dec., 1878	7,148$\frac{1}{9}$	12	9	3 years free.	Similar to that laid in Church Street. Henson's Street Paving Company.

8 Kensington Road	Palace Gate to Palace Avenue, and Hornton Street to Russell Road	Nov., 1880	20,932	9	9	2 years free.	6-in. blocks on 6-in. Portland cement concrete, $\frac{3}{8}$-in. joints, grouted with Portland cement. Messrs. Nowell and Robson.
9 Westbourne Grove, Norfolk Terrace, and Archer Street	Boundary of Paddington Parish eastward to Kensington Park Road	May, 1881	10,327$\frac{8}{9}$	9	3	2 years free.	6-in. blocks on 6-in. Portland cement concrete, laths between each row of blocks, and grouted with Portland cement. The Improved Wood Pavement Company.
10 Fulham Road ..	"Bell and Horns" Public House to Sydney Street, and from Charles Street to Drayton Gardens	Oct., 1881	15,455$\frac{6}{9}$	9	5	2 years free.	Same as above. Messrs. Nowell and Robson.
11 Palace Gate and Gloucester Road	Kensington Road to Old Brompton Road	Dec., 1881	16,860$\frac{5}{9}$	9	5	2 years free.	Same as above. Messrs. Lloyd & Co.
12 Old Brompton Road and Richmond Road	"Bell and Horns" Public House to West Brompton Station	May, 1882	30,360$\frac{5}{9}$	9	10	2 years free.	Same as above. The Improved Wood Pavement Company.
13 Uxbridge Road ..	Ladbroke Terrace to Holland Road	Oct., 1882	18,193$\frac{4}{9}$	9	5	2 years free.	Same as above. Messrs. Nowell and Robson.
14 Beauchamp Place (late Grove Place)	Brompton Road to Boundary of Chelsea Parish	Nov., 1882	1,877$\frac{1}{9}$	9	5	2 years free.	Same as above. The Improved Wood Pavement Company.
15 Church Court ..	Rear of Town Hall	July, 1883	322$\frac{8}{9}$	5	10	None.	Old blocks (taken up from High Street, Notting Hill) on 6-in. Portland cement concrete. Messrs. Nowell and Robson.
16 Elgin Crescent ..	Portobello Road to Clarendon Road	June, 1883	6,886$\frac{5}{9}$	9	8	2 years free.	Same as Beauchamp Place. The Improved Wood Pavement Company.
17 Portobello Road ..	Elgin Crescent to Railway Bridge	Aug., 1883	4,119$\frac{7}{9}$	8	8	2 years free.	Same as above, only 5-in. instead of 6-in. blocks. The Improved Wood Pavement Company.
18 Earl's Court Road	Kensington Road to Old Brompton Road	Oct., 1883	13,949$\frac{1}{3}$	9	5	2 years free.	Same as Beauchamp Place. Messrs. Nowell and Robson.

APPENDIX B—*continued.*

Name of Street.	Position of Paving.	Date when Paved.	Area of Wood Paving.	Cost per Yard.		Terms of Maintenance.	Description of Paving and by whom laid.
			Yards.	*s.*	*d.*		
19 Courtfield Road ..	By Gloucester Road Station	Nov., 1883	$415\frac{5}{9}$	10	0	2 years free.	Same as above. Messrs. Nowell and Robson.
20 Silver Street and Church Street	High Street, Notting Hill, to Clarence Mews	Oct., 1885	$7,828\frac{2}{9}$	7	8	2 years free.	5-in. blocks on 6-in. Portland cement concrete. The Improved Wood Pavement Company.
21 Church Court ..	Opposite Police Station ..	Oct., 1885	$84\frac{1}{3}$	9	0	2 years free.	Same as above. Messrs. Nowell and Robson.
22 Kensington Road	Russell Road westward to Boundary	May, 1886	$1,528\frac{5}{9}$	9	3	1 year free.	5-in. creosoted blocks on 6-in. Portland cement concrete. The Improved Wood Pavement Company.
23 Sydney Place and Onslow Square	South Kensington Station to Fulham Road	Nov., 1889	$3,509\frac{4}{9}$	9	6	1 year free.	4-in. creosoted blocks on 6-in. Portland cement concrete. The Improved Wood Pavement Company.

TOTAL AREA OF WOOD PAVING, $181,071\frac{8}{9}$ SQUARE YARDS.

No. 1 was repaved, September 1884, by Messrs. Nowell and Robson, at a cost of 7*s.* per yard.
No. 2 was repaved, September 1885, by the Improved Wood Pavement Company under their Contract for maintenance.
No. 3. $524\frac{7}{9}$ yards superficial of this length of wood pavement was repaved in October 1885, by Messrs. Nowell and Robson, at a cost of 6*s.* 9*d.* per yard, Henson's Street Paving Company having failed to carry out their contract for maintenance.
Nos. 4 and 5 were repaved, December 1887, by the Improved Wood Pavement Company, with 5-in. creosoted blocks, at a cost of 6*s.* 8*d.* per yard.
No. 5, part of High Street, Notting Hill (892 yards), was repaved in October 1890, by the Improved Wood Pavement Company, with 5-in. creosoted blocks, at a cost of 8*s.* per yard.
Nos. 6 and 7 were repaved, May 1886, by the Improved Wood Payment Company, with 5-in. creosoted blocks, at a cost of 6*s.* 10*d.* per yard.
No. 8 was repaved, March 1890, by the Improved Wood Pavement Company. with 5-in. creosoted blocks, at a cost of 8*s.* 6*d.* per yard.
No. 9 was repaved, December 1887, by the Improved Wood Pavement Company, with 5-in. creosoted blocks, at a cost of 5*s.* 8*d.* per yard.
No. 10 was repaved in October 1890, by the Improved Wood Pavement Company, with 5-in. creosoted blocks, at a cost of 8*s.* per yard.
No 12, part of Thurloe Place ($1894\frac{5}{9}$ yards), was repaved in February, 1890, by Messrs. Nowell and Robson, with plain 6-in. wood blocks, at a cost of 8*s.* 3*d.* per yard.
No. 14 was repaved in October 1890, by the Improved Wood Pavement Company, the old blocks being turned, and partly renewed with old blocks taken up from Fulham Road, at a cost of 2*s.* 6*d.* per yard.

APPENDIX C.

Return of Wood Paving Repairs, Year Ending March 1891.

The following schedules furnish the detailed cost of repairs to various wood-paved roads, the work being executed by the Vestry's workmen. The deals are purchased as required, at the market rate, and sawn into blocks of varying depth, at the Pembroke Road Depôt, where a saw bench has been erected, the motive power being supplied by the old 15-ton steam roller. Sound old blocks, when in stock, are used instead of new wood.

Road.	Date originally Laid.		Total area of Road.	Area of Road Repaired.	Cartage.			Materials.			Wages.			Use and Waste of Plant.			Total.			Cost per yard area Repaired.			Cost per yard total area.
			Yards.	Yards.	£	s.	d.	£.	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.
Church Street and Silver Street	Aug.	1887	$727\frac{8}{9}$																				
	Oct.	1885	$7,828\frac{2}{9}$																				
			$8,556\frac{1}{9}$	$289\frac{6}{9}$	1	7	1	11	13	10	11	14	0	1	4	9	25	19	8	0	1	9½	¾
Earl's Court Road	Oct.	1883	$13,949\frac{1}{3}$	1,002	4	7	1	23	1	3	37	12	2½	3	5	0	68	5	6½	0	1	4¼	1⅔
Elgin Crescent	June	1883	$6,886\frac{5}{9}$	$687\frac{1}{9}$	3	15	2	16	16	11	26	4	1½	2	6	9	49	2	11½	0	1	5	1¾
Fulham Road	July	1878	1,587																				
	Oct.	1881	$15,455\frac{2}{3}$																				
			$17,042\frac{2}{3}$	$538\frac{4}{9}$	2	15	0	21	14	2½	23	3	11	2	7	8	50	0	9½	0	1	10¼	¾
Gloucester Road and Palace Gate	Dec.	1881	$16,860\frac{5}{9}$	1,876	10	10	5	88	10	4	68	10	1	8	7	7	175	18	5	0	1	10½	2½
High Street, Notting Hill	Dec.	1878	$7,102\frac{8}{9}$	$57\frac{4}{9}$	0	10	0	1	9	7	2	2	7	0	4	1	4	6	3	0	1	6	⅛
Kensington Road	Nov.	1880	20,932	$15\frac{1}{9}$	0	2	1	1	3	5½	1	12	5	0	2	11	3	0	10½	0	4	7	—
Uxbridge Road	Oct.	1882	$18,193\frac{4}{9}$	$3,910\frac{8}{9}$	21	12	6	174	5	8	148	17	0	17	4	9	361	19	11	0	1	10¼	4¾
Old Brompton Road	May	1882	$30,360\frac{5}{9}$	$2,115\frac{2}{9}$	14	19	0	121	9	7½	82	6	9	10	18	9	229	13	1½	0	2	2	2
Portobello Road	Aug.	1883	$4,119\frac{7}{9}$	$219\frac{4}{9}$	1	14	5	11	19	7	8	11	10½	1	2	3	23	8	1½	0	2	1½	1¼
Brompton Road	Dec.	1878	$13,108\frac{7}{9}$	$197\frac{6}{9}$	0	12	6	6	15	10	6	14	11½	0	14	2	14	17	5½	0	1	6	¼
Kensington High Street	May	1877	1,714	$34\frac{1}{9}$	0	3	2	1	14	3	1	1	7	0	3	0	3	2	0	0	1	10	½

APPENDIX D.

RULES AS TO CONSTRUCTION OF VAULTS.

(*a*) The front or head wall of vault to be built in 14-inch brickwork in cement.

(*b*) The external face of brickwork not to project within two feet of the outer line of kerb.

(*c*) The space between excavated ground and brickwork of front wall of vault to be filled in with concrete.

(*d*) The crown of vault to be six inches below the under side of pavement, and the spandrils of arches to be filled in with concrete, so as to present a level bedding of concrete to follow the fall of the pavement.

(*e*) The coal-plate stones to be 3-inch York paving bedded solidly on concrete.

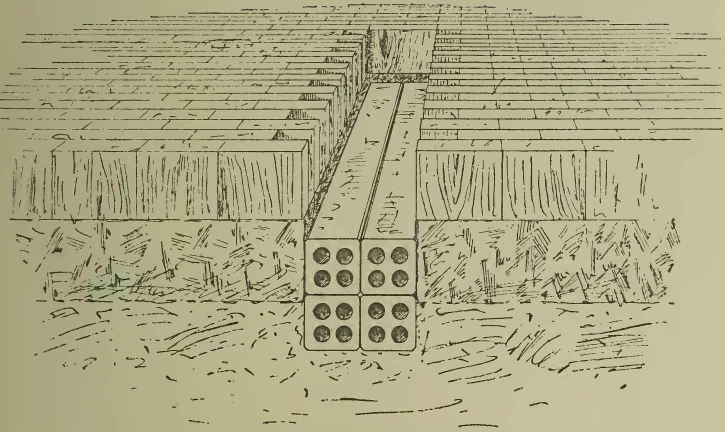
(*f*) The coal plates to be inserted in iron rings and the maximum size restricted to fifteen inches.

(*g*) The diameter of any glass disc in illuminating plates not to exceed three and a half inches.

(*h*) In taking over new streets, all coal plates not in conformity with the requirements of the Vestry will be rejected and replaced with approved plates and rings.

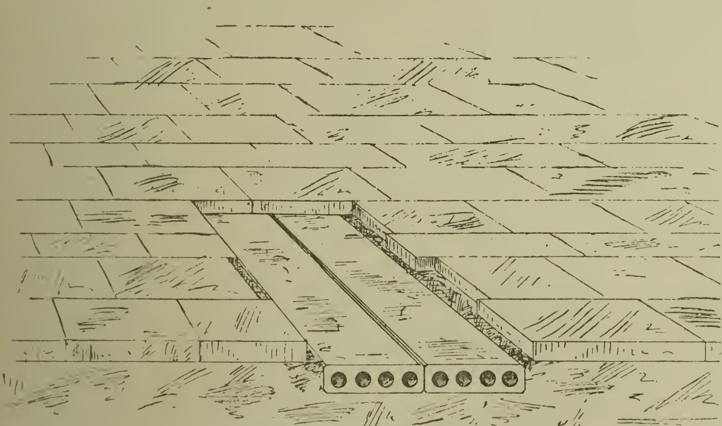
(*i*) Broken coal-plate stones in public streets in the Parish will be replaced at the expense of the Vestry, the expense of cutting the hole to be borne by the householder.

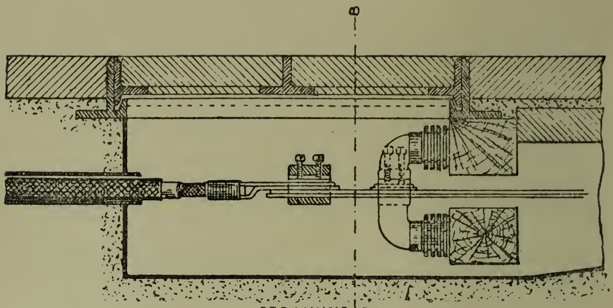
APPENDIX E



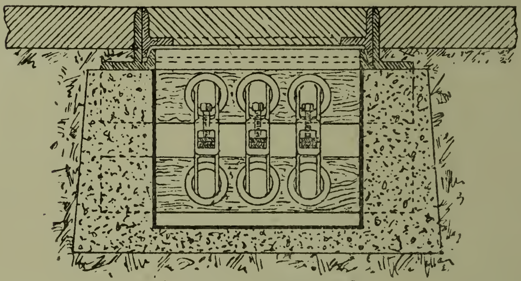
Scale: 1 inch to 1 foot.

Where it is necessary for the casings to be close under the paving of a Footway.

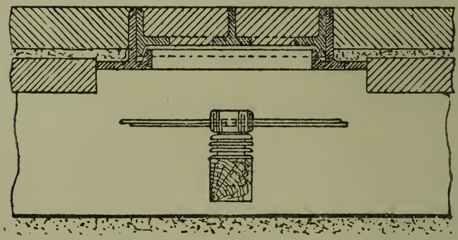




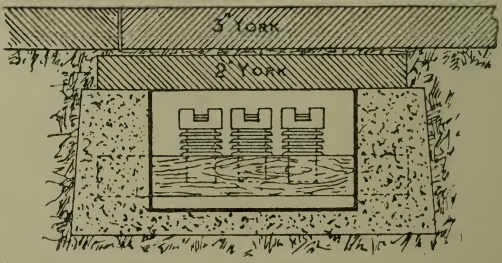
STRAINING BOX



SECTION THROUGH A.B

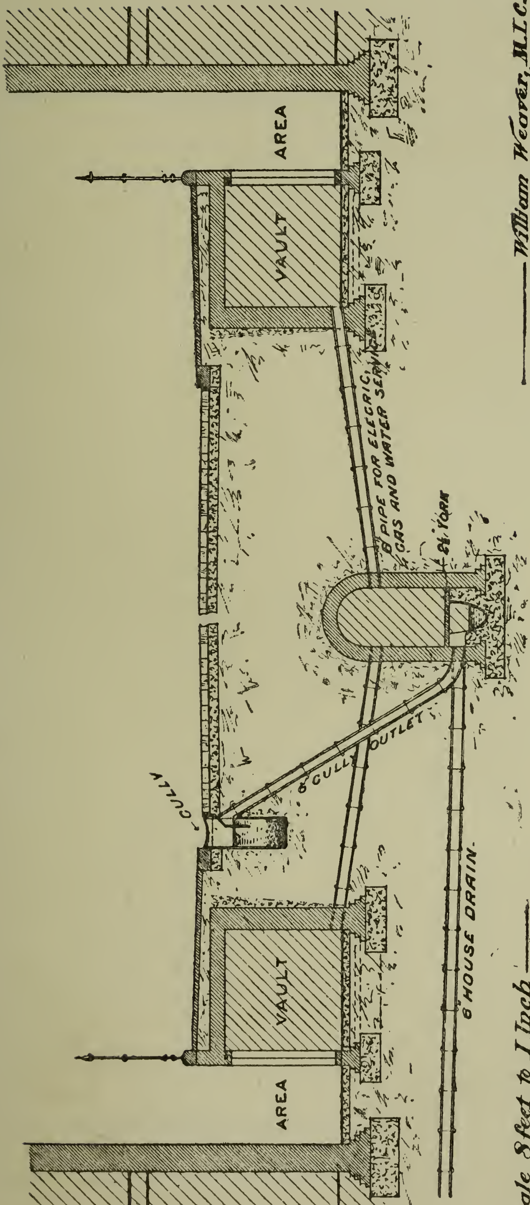


INTERMEDIATE BOX



END VIEW OF INTERMEDIATE BOX

APPENDIX F.



Scale 8 feet to 1 Inch

William Weaver, M.I.C.E.
Surveyor to the Vestry
Kensington, W.

DISCUSSION.

The President, in opening the discussion, said: I think we are all very much indebted to Mr. Weaver for the excellent and interesting paper he has given us. It must have taken him a long time to prepare the tabulated statements and to write this paper, which will be a very welcome addition to our annual volume, and will no doubt produce a useful discussion, especially the reference to drains and sewers. I daresay a great many of you, speaking as public officials, would agree with Mr. Weaver, but speaking as private sanitary engineers, you would take a different view. I hope some day we shall get such a perfect system of sewerage that we may safely venture to allow the house drains to act as ventilators to the public sewers, but with the present state of things this would be highly dangerous. The London sewers being designed to receive storm-water, are of large size, and in many cases are not self-cleansing, consequently the volume of sewer gas to be dealt with is considerable. In new systems where there are self-cleansing pipe sewers, properly proportioned to the work they have to perform, and regularly flushed, the quantity of gas is much reduced, and in such cases the good effect of up-cast pipe ventilators is very marked. I have not noticed in the paper any mention of automatic flushing. Perhaps Mr. Weaver would tell us whether he has tried it, and if so, with what result. I should like to see an automatic flushing tank at the head of every pipe sewer and house drain. Probably the Kensington sewers are too large for such a system to be effective. In coming to Kensington, where we find large public libraries and excellent public baths and washhouses, of which the inhabitants may justly be proud, I had hoped to have seen some scientific system for the disposal of dust. We have been invited by the Vicar to come here again on a future occasion, and I hope when we make that visit we shall have an opportunity of seeing a system of dealing with the dust by cremation second to none in the kingdom. There is no doubt that burning is the best system that can be adopted in a district of this character, where the difficulty of disposing of house refuse increases year by year and the cost also increases. I have no doubt a time will come when Kensington will not be able to get rid of its dust at any price. Many suburban and even rural authorities are already up in arms, and will not permit the refuse of London to be brought within their borders, therefore Kensington, like other parts of London, must take steps to provide some permanent method for disposing of its own refuse, and with an energetic and experienced engineer like Mr. Weaver, Kensington will find a way out of the difficulty. I trust that he will again bring forward the proposal to deal with the refuse by fire, and that he will carry his scheme through. At Hornsey we have a very successful system. We have burned the whole of the dust and refuse removed from the houses for two and a half years without a single complaint. In some respects the Hornsey district is similar to Kensington. The elevation of the district varies considerably (from 100 to 200 feet). The destructor unfortunately had to be placed in a low part of the district, with a view to save cartage, and if there were any nuisance from it, it would be certain to be observed in the higher portions of the district, where the best houses are situate—houses rated at 200*l.* or 300*l.* a year—but, as I have said, not a single complaint has been received, which shows that the refuse of towns can be dealt with in this way without causing the slightest nuisance.

Mr. C. JONES: I am most happy, at the suggestion of the President, to express my gratification of the paper produced by Mr. Weaver. It is when details like these are given to us, that we can realise the value of the work, and that there is something we can base a definite opinion upon. I do not know that I agree with our President altogether if I understood him right, when he says as sanitary engineers we might not agree with Mr. Weaver but as residents we might.

The PRESIDENT: I said as public officials we might agree with Mr. Weaver, but not as private sanitary engineers.

Mr. JONES: I rather wanted to draw that out, because my own impression is that the two must go hand in hand together; I do not think there must be any difference about that. We are one with our ratepayers; though they do not always think so perhaps. I am quite prepared to admit that, but at the same time we feel personally that their interest is ours and our interest is theirs. There are several interesting matters to refer to in the paper, and at the same time one would like to have free play in speaking of Kensington with all its reminiscences of the past, its history for so many centuries; that would be gratifying, but it is not our object to-day; but rather to deal with the prominent sanitary features which have been referred to in the paper. The President has referred to one, the disposal of dust. It was my gratification and pleasure to give evidence before a Committee of the House of Commons on behalf of Kensington, with reference to the very point upon which difficulty has occurred, viz. the disposal of dust. Living as it were next door to Kensington, we do object to the canal, or the banks of the canal, being used for the purpose of removing the dust and refuse even from so fashionable a neighbourhood. If they happen to come down our way we shall do our very utmost to prevent it, as we did two or three years ago, when we were stunk out by a Paddington contractor who was burning the refuse, but not in the proper way. I do think, however, the time is coming when the quotations of cost which have been given in the paper will have to be put up much higher. I have used those quotations again and again in the papers I have read with respect to the cost. And it is a most important factor, the cost which is being incurred by the removal of this refuse when the work could be done at such a minimum of cost, and when the necessity for *power* is developing itself more and more in our several districts. Why cannot you get the power for the electric light from the refuse which you are carting to Purfleet at 1*s.* 9*d.* or 1*s.* 10*d.* per load, when you could destroy it for 3*d.* a ton? In my own district—it may be a pet subject with me, but it is well for us to have hobbies—our cost is just 3½*d.* per ton, because we utilise the power in steam, in clinker, in road work, for pavements, in every imaginable way, and we shall use it directly for electric lighting. I have just thrown out these remarks in the hope that they may lead the way to other remarks, and I appeal to our friends in Kensington to consider before they set themselves against this interesting and up-to-date mode of dealing with house refuse.

Mr. Henry Richards: There is one point I should like to ask Mr. Weaver a question upon. Speaking of roads, he says the stone is broken to gauges of 2, 1½, and 1¼ inches. I would like to ask what is the nature of the gauge he uses, and whether he absolutely insists on the literal fulfilment of this clause. In my specifications it is defined as follows:—"Clause 2. The granite is to be of the best quality, free from mixture with chippings, dirt, or other substance, evenly broken by hand to a cubical form, and no stone is to be larger than will pass through a ring 2 inches in diameter. 2*a*. Also a price is to be given for granite of the best quality, free from mixture with chip pings, dirt, or other substance, evenly broken by hand to a cubical form, no stone to be larger than will pass *in every direction* through a ring 2 inches in diameter. Why I bring this forward is, because in my own district of Barnes and Mortlake the question was brought up last year, and it was decided that this clause, which is almost universal in England, that the stone shall go through a 2-inch ring, shall be literally insisted upon. I had to write a letter just recently to our contractors for the coming year, that we would have a stone that would pass the gauge, and the result of that has been that the price has very considerably increased. The lowest price we had from Turner and Sons—who previously supplied our district—was 15*s.* 11*d.* for stone complying with clause 2, and 20*s.* 10*d.* for that required by clause 2*a*, whereas the price we had it at last year was 14*s.* 10*d.* I may say, also, that all the contractors wrote letters with their tenders that they would not bind themselves to supply a material which actually passed through a ring; that they would supply what is generally known in the trade, and accepted by the trade, as 2-inch broken granite. I would like to know how Mr. Weaver deals with this subject, because it is one of great importance to every surveyor in the country.

Mr. C. H. LOWE: As a metropolitan surveyor, I should like to offer my thanks to Mr. Weaver for his excellent paper, and I feel sure that we shall all profit by the remarks he has made, especially upon the sewerage and drainage matters. Perhaps no district of the Metropolis has suffered more than Hampstead from what is known as sewer gas, being as it were a sort of ventilator by its elevated position to the lower districts. Mr. Weaver states that "the common sense and radical cure for sewer smells is for each house drain to act as a ventilator." I should like to ask whether that proposition was placed before his Board, as I find that in Appendix A, clause 10, of his interesting paper, he states that "all water closets in the lower floor of premises, and all surface drains, sinks, gullies, rain-water pipes, and other connections shall be well and efficiently trapped by syphon or other approved trap." With regard to the water test, we have experienced considerable difficulty in carrying it out satisfactorily, for in some cases, even after the water test has been applied, owing to fractures taking place in a joint or pipe, the drain has leaked. If the water test is to be enforced, then I am strongly of opinion the down-pipes and all fittings in the upper part of the house should be tested by the local authority, because if that is not done you are rather emphasising the evil than correcting it, by providing an air-tight service pipe for the supply of sewer air to the upper floors of your houses. It is a question whether a local authority should not be responsible that all the fittings and plumbers' work are properly constructed and carried out. With regard to steam rollers, my Board use two —a 15 ton, and 10 ton—and I am glad to say we have had no difficulty up to the present with gas or water mains, such as stated in the paper. From the snow-clearing clause of the Public Health Act I think we are all suffering at this moment. We have as yet had no fall of snow to speak of, but we have had to spend a considerable sum of money to meet, if I may say so, this absurd requirement; however, we must not be the parties to cry out *non possumus.* If the Government has placed this duty upon the authorities, we must perform it as best we can. Doubtless before long the Vestries will find the cost will be so great that no sane ratepayer will wish his Vestry to carry this clause out in its entirety. With reference to the disposal of house refuse, the Hampstead Vestry has adopted the destructor mode of disposal. They could not find a suitable site to place a destructor in the parish, but found a very good position near Willesden Junction. I see my friend, Mr. Mair, of Hammersmith, is here, and if we have committed any nuisance, no doubt he will tell you, for he looks very sharply after us. Up to the present I may state we have not had a complaint which has proved to be well founded.

Mr. G. E. Eachus: It falls to my lot to act both as a public official and as a private engineer, and in both capacities I should be disposed, generally, to agree with Mr. Weaver's conclusions as set out in his paper and appendices; but I do not like a sewer to be made so large as to be capable of access unless it is necessary for the flow, for the simple reason that it becomes a large receptacle for deposit on the walls and for sewer gas. If it is necessary to get access, as I quite admit it to be, to each drain outlet, I think that result would be better obtained, and at less cost, by putting more ventilating and access manholes in, and connecting all house drains at these manholes. You could then make your sewers small enough to be self cleansing, and at the same time get access to all your house drains, without the men having to travel through the sewers, and without the necessity of keeping the manholes absolutely open while the men are in the sewers. In London the necessity of keeping the manholes open in this way often involves the construction of costly side entrances. I would therefore suggest that instead of large built sewers, stone-ware pipes should be used, with ventilating manholes placed at more frequent intervals in the streets. With reference to the question of disconnection, it is not only a question of ventilation we have to deal with, but the communication of disease through the sewer, and that involves the necessity of disconnecting each house from its neighbour. Trapless drains, like trapless closets, require also most perfect ventilation, and most careful and periodical inspection. With reference to the carrying out of the system recommended in the body of the paper, I think Hornsey is a fairly good example of the way in which that has been done, by making the house drains act as ventilators for the sewer, but the configuration of that district lends itself in an exceptional manner to the carrying out of that system, because all the ventilators are at different levels, and you get in a measure in this way up and down cast shafts. I notice that Mr. Weaver has adopted a sewer shutter flap. Something of that kind was shown by me at the Inventions Exhibition, with water joints, but although a good preventive of back draught I have abandoned it now in most places, because I find generally that a shutter flap is a receptacle of deposit. Of course you can overcome that partially by cleansing, but only partially. With reference to the cleansing of sewers by machines, personally I think if a sewer can be cleansed without a machine, so much the better. I am a great advocate, when you have to clean a sewer, of putting on the water-hose and cleansing it in that way. I fully endorse the remarks of the other speakers as to the excellence of Mr. Weaver's paper.

Mr. James P. Norrington : I propose to refer to the suggestion of Mr. Weaver in his paper, that the sewers might be ventilated by means of the house drains ; and that syphon traps should be dispensed with in the main drain of the house. I do not know the precise manner in which Mr. Weaver would carry out his proposal, but suppose the sewer gases would be allowed to pass through the main drain of the house to the ventilator at back. This method would, I think, be a very undesirable one, as the inhabitants of the house would be liable to suffer from the effects of sewer gas, should any defects occur in the drains under the house. My Vestry have adopted the principle of ventilating the sewers by means of ventilators carried up the fronts of houses, but the Vestry is also very careful to have the house drains carefully intercepted from connection with the sewer by means of a trap and inspection chamber in front of the house; and the owners of the property are also asked to carry a ventilating shaft 4-inch drain up the front of the house from between the trap and the sewer. I have also put up a number of shafts of this kind wherever there have been complaints of the sewer ventilators in the streets. Lately many enquiries have been sent me as to the cost of the keep of horses. Mr. Weaver gives the cost as 14*s.* 10*d.* per week. During the past year the cost of the horses belonging to the Fulham Vestry was 15*s.* 2*d.* per week, but that year was a very expensive one owing to the price of fodder. The previous year was as low as 13*s.* 4*d.*, and the figures for four years are, 1887–88, 14*s.* 3*d.*; 1888–89, 14*s.* 5*d.*; 1889–90, 13*s.* 4*d.*; and 1890–91, 15*s.* 2*d.*, so that the figures for last year must not be taken as an average. I notice that the Kensington Vestry has six sand distributors. My Vestry has five, and I can recommend them to you all as exceedingly useful articles. My parish receives a good deal of praise for the efficient way the roads are sanded in frosty whether. There is another matter referred to by Mr. Weaver in his paper upon which I will make a few remarks which may be of interest to this Association; and that is the construction of a bridge to continue the Cromwell Road into Fulham over the West London Railway. This will probably be the first scheme passed by Parliament to which the principle of "betterment" or "melioration"* will be applied. The chief points of the scheme are briefly these: The London County Council propose to pay one-third of the cost (total cost estimated at 63,000*l.*), the Vestry one-third, and the remaining third will be charged as an improvement rate upon the area within a circumference of half a mile from the Fulham end of the bridge. It will, I think, be interesting to watch the result of this proposal of the London County Council. There is no doubt in my mind that it is reasonable to charge for "betterment" or melioration at that end of the bridge, because the value of a great number of properties will be permanently increased 10 to 12 per cent. by the construction of the bridge. The difficulty will be, of course, to define the precise line where the charge for betterment should cease. I have no further observations to make, except to also express my indebtedness to Mr. Weaver for the very interesting and valuable paper he has read to us.

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* "Melioration" is referred to by Mr. Samuel Pepys' Diary, date the 3rd of December, 1667, in the following words: "He (Sir Richard Ford) tells me also, speaking of the new street that is to be made from Guildhall down to Cheapside, that the ground is already most of it bought. And tells me of one particular, of a man that hath a piece of ground lying in the very middle of the street that must be; which, when the street is cut out of it, there will remain ground enough each side to build a house to front the street. He demanded 700*l.* for the ground, and to be excused paying anything for the melioration of the rest of the ground that he was to keep.

"The Court consented to give him 700*l.*, only not to abate him the consideration, which the man denied, but told them and so they agreed, that he would excuse the city the 700*l.*, that he might have the benefit of the melioration without paying anything for it. So much some will get by having the City burned. Ground by this means that was not worth 4*d.* a foot before, will now, when houses are built, be worth 15*s.* a foot."

Mr. Lovegrove: I cannot refrain from expressing my thanks to Mr. Weaver for the very able paper, so comprehensive and so full of information, just now read. I may also congratulate the Vestry of Kensington upon the possession of so able an official. He has proved his value and fitness in the past and the present, and the prospective looks well. There are so many points in the paper, that one must go away and carefully digest it. With regard to sewer ventilation, Mr. Weaver knows that we have had three or four nights' discussion at the Institution of Civil Engineers on that very important question. I shall not touch upon that matter except to say that in 1857 I patented a system of ventilating sewers and drains by a method which is now so universally adopted, and a copy of my paper can be obtained at the Patent Museum. I am very anxious that this meeting should not dismiss the snow question; should not allow that question to melt away. I hope the meeting will come to a firm decision to move in that direction. When the Public Health (London) Bill was in its early stages I was present with three of our members in the lobby of the House of Commons. I then pointed out that so sure as this clause became law it would have to be repealed. The member said, "The fact is that we shall lose the Bill if we do not put it in"; and I said, "Lose the Bill rather than commit so gross an absurdity." The clause is now law, and the sooner we get rid of it the better for all of us.

Mr. J. P. Barber: I feel very glad that Mr. Weaver has given us this paper, because although we in London have not so many works to show our professional brethren from the country as they have to show us, the paper will indicate that there are many points connected with the work carried out in London which are useful to those in the less thickly populated towns in the country. With reference to the water testing of drains, I notice Mr. Weaver says, "Before any drain work is commenced, plan and notice has to be lodged with the Vestry Surveyor, and the whole of the work is supervised by his staff, the underground drain being water tested." I should like to ask which portion that refers to. I presume it does not refer to the part between the sewer and the premises. Then I would like to know when that test is appplied, because if it is applied two or three days after the cement joints have been made, the people who have done the work will say, as they have done to me, it is unreasonable to expect the drains to be watertight within two or three days after the joints have been made, because there may be two or three feet fall, and it is unfair to test the cement in that time with a head of two or three feet of water. I would like to know if Mr. Weaver has successfully met and grappled with that difficulty, because it is a point we are much interested in. I quite agree that joints of all drains and pipes should be watertight, but I am sorry to say that many builders think differently, and seem to think it a matter of choice. Then as to the water test. I should like to ask what system is used, because where there is an intermittent supply the water may give out before the drain is filled; that is a difficulty which requires some overcoming. I believe with Mr. Weaver that Jarrah timber for wood paving will probably be much used in the future. Being hard, I think it might be laid without creosoting, as it contains sulphate of copper, but we do not get the same freedom from noise from it that we do from the deal. Have the joints a tendency to open and the blocks to split at the edge? I think no one will be disposed to disagree with Mr. Weaver as to the time when a macadam road should be converted into a wood-paved road on the ground of economy. Mr. Weaver says that wherever a road costs 1*s*. per superficial yard per annum for maintenance, it is desirable to convert it into a wood-paved road. I should feel inclined to put it at a lower figure than that. A shilling per yard would include a coating once every year. I would go so far as to say that when a macadam road requires coating every eighteen months, and the cost reaches 8*d*. per yard super per annum for maintenance, it would be a great public convenience—I will not say it would be economical, but a great convenience to the traffic, and the residents and tradesmen in the road—to convert it into a wood-paved road. I should like to ask whether the Vestry of Kensington admit they are responsible for the watertightness of the roads. Mr. Weaver speaks of vaults under the roads, and I should like to ask if he has ever had demands on account of water percolating into those vaults. I always deny the responsibility for making or maintaining roads watertight, but some people seem to think that roads are not only made for traffic, but for the protection of vaults underneath them. With regard to destructors, we, in London, are being driven to them. I think eventually, and before very long, we shall not be allowed to dispose of the refuse as we now do. Every year the cost of the burden is advancing, and advancing very considerably. As to using the sweepings from the macadam roads, Mr. Weaver tells us he is able to get a grit which is very useful for sanding purposes. We are able to sell the grit from our roads at from 2*s*. to 4*s*. per yard, and the pebbles I have used for rough concreting; mixed with blue lias lime they make a very good concrete, but I would caution any one against mixing the residue obtained by washing sweepings obtained from macadam roads, with Portland cement, as the concrete thus made is of a very friable description.

Mr. Weaver, in reply, said: There is only one automatic sewer flusher at work, viz. in Bramham Gardens West; this flushing tank is supplied with water from the waste and rain-water pipes from the adjoining mansions. Many of the large houses in the parish are fitted with automatic flushing tanks.

With reference to the question of sewer ventilation, there is a good deal of truth in the assertion, that engineers are in a measure compelled to take different views as to drain trapping or disconnection, according to whether they are acting in a public or in a private capacity. There would be very little chance for an engineer to rapidly increase his private practice, if he advocated sewer ventilation or aëration by means of the house drains; the engineer who wishes for pecuniary success, is much more likely to achieve it, by giving assurance to clients that *their* houses are made perfectly safe sanitarily, even at increased health risk to their neighbours, than by advocating the advancement of the general good by the combination of individual effort. With regard to the carrying up of ventilating pipes on the sewer side of the disconnecting chamber, the author has (like Mr. Norrington) been successful in inducing some builders to carry out such plan, and if it were adopted generally, it would answer all practical purposes. Kensington drainage rules (No. 15) recommend the fixing of such pipes, but there is no legal power of enforcement.

With reference to drain supervision; in Kensington house drains are tested by inserting a plug in the mouth of the drain at the intercepting chamber, and charging the drain with water to the top of the rear inspection chamber, or as high as the various connections will permit. With but few exceptions inspection chambers are built at the rear, and at other points where requisite to receive branch drains. These chambers are required to be made watertight; where built with unglazed bricks they are rendered with Portland cement trowelled to a smooth face; if glazed bricks are used they are laid in Portland cement; where no inspection chamber is constructed at rear, the drains are tested to the top of clearing eye as required by rule No. 4. After the line of drain is agreed upon and the work set out, a printed and addressed post-card is left with the builder, who forwards it to the office when the drains are ready for testing. The officials then visit the work, and the drains are charged with water as before mentioned; the water line is carefully marked in the inspection chamber, and whilst the drains are charged an assistant examines each joint so as to detect any leakage. All leaky joints are marked and have to be remade and the drains retested. The inspection chambers are sometimes found to leak, but the weak spot is generally where the various drains are connected to the inspection chambers. It is essential that the inspection chambers should be watertight, as in the event of stoppage, the drainage heads back and escapes through the leaky manhole into the surrounding earth. Stoneware drains, if properly jointed and formed with good pipes, will stand the test under a 3-feet head of water, and have been tested under a head of 4, 5, and 6 feet, without showing signs of leaking. Porous pipes are easily detected when charged with water, as they will be found to sweat and beads of water stand on their surface.

The pipes are usually laid with a space left beneath collars, or laid on bricks to lift them off the concrete bed, so as to secure a perfect joint all round alike, and after the drains have been tested, concrete is tucked beneath the pipes so as to secure a solid bearing throughout, and beneath the house, the drains are required to be covered with concrete. In some cases a lidded or access pipe is fixed in the drain, between the intercepting trap and sewer at the head wall of vault, or at the boundary of private premises, and a plug is inserted at this point so that the whole of the drains, intercepting chamber, and inspection chambers can be charged with water at the same time. This is an excellent plan, but not insisted upon by the Vestry, and as a general rule the intercepting chamber and main drain beyond it towards the sewer, is not tested, but branch drains entering the intercepting chamber are tested separately. As to the time that should elapse after the joints are made before the drains are tested, this is a matter left with the builder, who, for his own sake, will not notify the Vestry until the joints are fit; the time varies with the different cements, some setting much more quickly than others. There is a possibility of drains which have been tested being found to leak subsequently, and an instance has come under my notice where it was alleged that hot cement had been used which expanded in the joints and cracked them. This is a matter against which it is extremely difficult to guard, as the cement may blow a considerable time after the joints are made and the drains covered up. There is no time to test cement for this purpose, and it might be advisable to mix a certain quantity of sand with the cement, say, 1 of sand to 3 of cement, or "kill" the cement by mixing it up, allowing it to partially set and then remixing it. Joints made with cement treated in this latter manner are exceedingly hard and watertight, and although the tensile strength of the cement is weakened, it is doubtful if this is of consequence, as the cement may be looked upon as a stopping material not submitted to a tensile strain in a pipe joint.

In some cases drains, where laid by inexperienced workmen, have to be tested four or five times before they can be passed as sound, but in the majority of cases the drains are found either perfectly sound or with but slight leaks upon testing for the first time, and this is owing to the fact that every builder is aware, before commencing to lay the drains, that they will be tested with water, and will not be passed until sound, so that he tests them for himself prior to sending for the officials.

The water for testing is drawn from the house supply in the case of reconstructions, and from the water provided for building purposes in the case of new houses, and no difficulty is experienced on this score.

Four-inch, 6-inch, and 9-inch plugs are kept by the Vestry and loaned to builders requiring them. The soil pipes and connections to upstairs W.C.'s are not tested, but they are thoroughly examined, and it must be borne in mind that in nearly every instance an intercepting trap is fixed on the main drain, also that soil pipes are generally placed on an outside wall, and when inside the house they must be of lead. Whilst fully admitting that it would be advisable to test this part of the work, it is not possible to do so without largely augmenting the staff. All the upstairs part of the work is supervised, all wastes are seen to discharge into the open, and many pan closets are removed by persuasion. Their removal in old houses cannot be enforced, but by pointing out their defects, we are successful in getting many of them removed.

With reference to the enquiry of Mr. Richards—ring gauges are used for the broken granite, and the author is satisfied if the general bulk, free from sittings, will pass the gauge. The rejection of the material on the grounds that some small proportion is slightly over or under the gauge, would, in the author's opinion, be a straw-splitting interpretation of the conditions. A large percentage *slightly* over the gauge is nothing like so objectionable as a comparatively small percentage *greatly* over the gauge; an absolute uniform adherence to the gauge would entail a great increase in the price of the material without adding to its working value, and the proper enforcement of the contract clause as to size must be left with the other conditions as to quality, &c., to the discretion and integrity of the engineer or surveyor.

With regard to the observations of Mr. Barber as to vaults and roads, the author has a standard form of letter to the effect that it is no part of the duty of the road authority to form and maintain watertight roads, and pointing out that it is the duty of the house owner to kept the vaults in good repair, to the exclusion of the water. At the same time, if there are any depressions in the road or channel, they are filled up and made good. As to converting a macadam road into a wood-paved road, when the former costs considerably under 1*s*. per yard to maintain, the economy of the conversion hinges (as stated in the paper) on other considerations in addition to the primary one of the relative cost of maintaining the two different kinds of roads; quietude may be urgently needed in particular streets owing to certain professions, businesses, places of worship, &c., and the assurance of that quietude, by laying down wood, may add to the popularity of the street or district, and thus increase its rateable value, to an extent sufficient to compensate for the additional cost of road maintenance.

At the conclusion of the discussion the members were entertained by the Vestry of Kensington to luncheon, which was served in one of the Committee-rooms; and on the motion of the President, the thanks of the Association were accorded to the Hon. and Rev. Carr Glyn, and the members of the Vestry, for their hospitality, and for *their kindness in granting the use of the Council Chamber for the meeting of the Association.*

The members then proceeded in brakes to inspect the various public works of Kensington. The first stoppage was at the Recreation Ground, Notting Dale. This was originally intended as the site for the destructor; but on the defeat of the Bill for this purpose in the House of Commons, Mr. Weaver converted it into a public recreation ground. The present use of the land has been much appreciated by the residents in the locality, as the grounds have been laid out for both children's and adults' recreation; though the parliamentary decision has added considerably to the difficulty and cost of dealing with the refuse of the parish. From the band-stand which has been erected on the ground, Mr. Weaver explained the purpose for which the ground was originally intended, and remarked that there was no doubt it was a great boon to the neighbourhood, which is a very poor one, although, as an engineer, he was sorry he had not a destructor there.

From the Recreation Ground a short drive conveyed the member to the Kensal Wharf, where very elaborate and admirable arrangements are made for barging refuse collected from the streets and houses of the parish. Stables, store-rooms, and other buildings, all completely equipped for the various works, are erected on the adjacent land. The Warwick Road and Pembroke Road Wharfs were next visited, and here members had an opportunity of inspecting Mr. Weaver's snow-plough, a description of which is given in the paper. The next visit was to the Electric Lighting Station of the West Brompton House to House Electric Supply Company, Limited, where the members were met by Mr. Hammond, who gave a lucid description of the works and plant and method of lighting. The leading feature of the system of electric lighting adopted by the House to House Supply Company is the distribution of electrical energy in the form of high-tension currents, and its conversion into low tension in the houses lighted. It is claimed that by this means the size of the conductors is reduced to commercial limits. The conversion of the current from high to low tension is effected at each house by convertors of special form invented by Messrs. Lowrie & Hall, the Company's engineers. The station when fully completed will contain 12 *sets of plant, with a capacity of about* 50,000 *incandescent lamps, representing about* 100,000 *lamps. The engines are of the horizontal type, and made by Fowler, of Leeds; the boilers by the Babcock & Willcox Company; and the* *dynamos by Elwell-Parker & Company, Limited. The dynamos are multipolar alternating current dynamo-electric machines, capable of maintaining economically and safely an output of* 100,000 *watts. The speed is* 350 *revolutions per minute. The mean speed, at which the armature conductor is passed by the field magnets is about* 6000 *feet per minute, and the number of alternations* 10,000, *or* 5000 *complete phases per minute. The E.M.F. is* 2000 *volts.*

From West Brompton the party proceeded to the Refuse Disposal Company's Works at the Salopian Wharf, Chelsea, where an opportunity was afforded of seeing the ingenious uses to which house refuse may be turned. The next stopping place was at the wharf, Lot's Road, Chelsea, where Mr. Weaver's machinery for the washing of the refuse from flint and macadam roads, with a view of recovering and turning to profitable use the grit and sand which the sweepings contain, was inspected with evident interest.

The members then visited the Kensington Court Lighting Station of the Kensington and Knightsbridge Electric Lighting Company, where they were received by Mr. W. H. Miller, the resident engineer, who showed them over the establishment, and described the mode of working. Mr. Miller explained that the Kensington Company are working on the low-tension system. The current is worked at a pressure of 200 *volts, as against* 2000 *volts with the high-pressure system. The whole of the electricity is generated in dynamos, and during certain hours of the daytime the surplus current is passed to the accumulators and stored there until the engines are stopped, when the current is supplied from the accumulators, thus saving a third shift of men. The accumulators are also useful to meet a sudden demand in the case of fog, or in the event of any break-down of machinery. The accumulators are sufficient to supply light to every lamp for half an hour ; and as only part of the lamps are alight at any one time, they are able to supply for a much longer period. To see the pressure in each street or district supplied from the station the Company have a pilot wire which comes back on to a volt ampere or pressure meter, so that it is possible to tell the pressure in every part of the district. The Company have* 30,000 *lamps connected with the station, but find that the maximum number in use at any one time is* 11,000 *or* 12,000 *lights. The price charged for the supply of the electric light by meter is* 8*d. per unit, but Mr. Miller* *says it is only a question of the number of lamps supplied as to when the Company can reduce the price. For the purpose of comparison as to the relative cost of gas and electricity, Mr. Miller considers 8d. per unit about double the price of gas. The actual cost of production of the electric current at Kensington is 2½d. per unit, running up to 3d. per unit in the summer months; and capital and other charges bring up the gross cost of production to 5d. or 5½ per unit.*

The accumulators had been working six years and had not required renewal. They had been writing off 12½ per cent. per annum, but they had found during the last year or two that the depreciation had only been 3 per cent., but they would not like to depreciate that small amount.

In the evening the members dined together at the Holborn Restaurant.

DISTRICT MEETING AT DUBLIN.

March 29th, 1892.

Held at the Institution of Civil Engineers (Ireland), Dawson Street, Dublin.

Mr. A. O. Lyons, *in the Chair.*

It was proposed, seconded, and carried that Mr. R. H. Dorman, County Surveyor, Armagh, be appointed Honorary District Secretary for Ireland.

No other business was transacted.

DISTRICT MEETING AT NOTTINGHAM.

April 29th, 1892.

Held in the Council Chamber at the Exchange.

T. De Courcy Meade, President, *in the Chair.*

The members were received by the Mayor (Councillor R. Fitzhugh), who said: Mr. President and Gentlemen—In the name of the town, I wish to give you a very hearty welcome, and I trust you will enjoy your visit to Nottingham. There is no doubt that the visits of such societies as yours to different towns do a great deal of good. You exchange ideas, come into contact with new people, and, I may say, see new things. I hope such may be the case during your visit to Nottingham. Our worthy engineer, Mr. Brown, has executed many works for the town of Nottingham, and I think I may truly say they have been done with credit to himself and with satisfaction to the town. At any rate you will see a good many of those works during your visit, and you will be able to judge for yourselves. We have some very excellent works in Nottingham which I hope you will be able to visit. You will then see the class of work that has been done, and I hope it will meet with your approval. Mr. Brown, I am sure, will do everything he can for your convenience, and if I, as Mayor of this borough, can do anything to assist, I shall only be too pleased to do so. I now give you, in the name of the town, a very hearty welcome.

The President: Before we commence the business of to-day, I desire to express to you, Mr. Mayor, our thanks for the kind words with which you have welcomed us this morning. In this busy and important town we shall see much that will be of use to us, and we shall no doubt take home valuable information. What you have said of your worthy engineer, Mr. Brown, we can confirm —he is known personally to many of us. We always look up to

Nottingham as a town which has taken a front place in municipal engineering, and it was with much pleasure I heard that a meeting of our Association had been arranged to take place here. I look forward to our visit to the subways and other works which have been so ably designed and carried out by Mr. Brown.

Mr. J T. EAYRS: I beg to move that Mr. Davis, County Surveyor of Salop, be reappointed District Secretary for the Midlands. He has occupied that position for many years, and he has done very good service to the Association.

Mr. R. GODFREY: I have very great pleasure in seconding the re-election of Mr. Davis as District Secretary for the Midlands. He works heartily and cordially for that district, and as a member of the Midland district I am very pleased to second his re-election.

The proposition having been unanimously adopted,

Mr. A. T. DAVIS said: Mr. President and Gentlemen—I am much obliged to you for re electing me to the position of Honorary Secretary to the Midland District. All I can say is: I will do, as I have done in the past, my best for the interests of the Association.

The following paper was then read.

MUNICIPAL WORKS IN NOTTINGHAM.

By A. BROWN, M. INST. C.E., BOROUGH ENGINEER.

STREET SUBWAYS.

IT has been said that if the human skin were transparent none of us would dare to move a limb; we should be afraid to touch or disturb in any way that wonderful and delicate organism which would be exposed to our view. It appears that the time is fast approaching when our busy streets and main thoroughfares in large towns would fill us with just as much awe if the surface were transparent, and we could see what there is beneath that surface. There are now the main sewers, gas and water-pipes with their numerous branches, telegraph and telephone wires, and in the larger and more important of the towns, pipes for carrying hydraulic power or compressed air, pipes and conduits for electric light cables, conduits for cables for cable tramways or for electric tramways; and if the lead of our American friends is followed, we shall have to add another pipe for carrying steam for power and for heating purposes. There is therefore beneath the surface what may be compared to a living organism, which is daily growing in complexity.

Considerable difficulty is experienced in dealing with this complex system: the surface of the roads is cut into, almost over its whole surface, for the purpose of laying and replacing from time to time the various pipes referred to, and the borough engineer is expected to maintain the surface in a good condition after the operations of various people who disturb the paving, and who have very little interest in relaying or maintaining it satisfactorily. It does seem to be somewhat of a blot on our boasted civilisation that when a pipe has to be taken up, in a busy and crowded thoroughfare, the system usually adopted is to tear open the street whatever may be the class of pavement, lay in the pipes, and then "make good" the surface. Those two little words—make good—cover a lot of ground, but are somewhat misleading; it is as much an engineering impossibility to immediately restore the paving over a newly filled up trench to its original condition, as it is a physical impossibility to heal a serious wound on a human body without leaving a scar.

The streets may be compared to a human body continually undergoing surgical operations; not only should the damage to the surface of the streets be taken into account by this condition of things, but consideration should be given to the hindrance to vehicular traffic when the streets are "up," and also to the pecuniary loss to tradespeople in the street.

The only remedy for this is for large towns to lay down, where possible, subways in the principal streets and crowded thoroughfares, and especially in the case where new streets are made in connection with public improvement schemes.

The first subways constructed in this country were in London about the years 1860–62, and the first subway outside the Metropolis was constructed in Nottingham in the years 1861–62, in Victoria Street and Queen Street; these were followed a year or two later by subways in Lister Gate and Market Street, and in the year 1886 the author designed and carried out subways in Albert Street and Wheeler Gate.

To show the value of such works in the street called Victoria Street, in which is situated the General Post Office, there are, besides the gas and water pipes and connections, no less than six pipes containing telegraph wires in this subway, and not one single stone was disturbed in this carriageway for 25 years, and in that period not one single penny was spent on repairs in this street.

The author proposes to describe to you some subways which are now being constructed under his direction, on what is known as the Condemned Area. This site, which has an area of about 12,500 square yards, was declared an unhealthy area, and was purchased under the Artizans and Labourers Dwelling Act 1875; it was covered with a wretched and disreputable class of property, and was very much overcrowded. The plans, which are hung upon the walls, show the area and the method of laying out the streets on the same for building purposes; it will be seen that the streets form on plan the letter Y. The street on the west side is 48 feet wide, and that on the east side 50 feet wide, the short length of street forming the tail of the letter Y is 60 feet wide. The subway proper is 10 feet wide and 8 feet 6 inches high, with semicircular arch, and is ventilated by means of gratings at the surface level of street about 48 feet apart, also by three side entrances and by open grating in refuge at lower end of 60-feet street. The sideways, which form the means of communication between the subway and the vaults, are placed ordinarily about 40 feet centre and centre, and are 4 feet high and 3 feet wide. The sewer is constructed under the floor of the subway, and is a 15-inch earthenware pipe, with Hassall's patent single lined joint.

Under the causeways on each side of the streets vaults are constructed, which are each 8 feet 6 inches wide by 9 feet 3 inches long, and about 7 feet high; these vaults are rented by the purchasers of the building lots adjoining.

The floor of the subway is laid with cement concrete brought to a smooth surface, and the floors of the sideways and vaults are laid with bricks.

Along and under each sideway is laid a 9-inch pipe with a Buchan's disconnecting trap and air inlet, and beyond is a right- and left-hand junction for receiving the drainage from the properties.

In the subway are fixed brackets, upon which may be placed pipes containing telegraph and telephone cables, the gas, water, and any other pipes being laid on the floor of the subway, or on iron standards fixed to the floor of the subway. At convenient distances hydrant chambers are built over certain of the sideways, in which are placed the fire hydrants and valves.

By this method of construction access can be obtained to and any alterations and additions made to sewers, gas, water, and other pipes, and the house connections therewith; the fire hydrants and valves can be examined, repaired, and renewed without taking up or disturbing one single stone in the surface of the street. The life of the iron pipes and connections in the subway is practically everlasting, as there is no rust, and the expense of relaying mains and especially gas services through this cause is saved.

In the execution of the works very considerable difficulty was encountered in consequence of the number of rock cellars which were met with during the operations; the general plan hung upon the walls gives but a faint idea of the network of cellars. One cellar is 370 feet long, and would hold a regiment of soldiers; on the site of all the main walls borings were made 10 feet deep in order to discover these cellars, the bulk of them are within a few feet of the foundation walls of the subways, and these walls of course had to be carried down to the solid. Nottingham was, in olden times called Snotteyn-ham, which means the town of caves, and the name was singularly appropriate.

The author has heard that there is considerable doubt in the minds of some engineers as to the possible effects of a very severe frost on the water pipes in the subway.

During the somewhat severe frost in the early part of this year, the maximum, minimum, and 10 o'clock a.m. temperatures inside the Albert Street subway were taken, and the similar and corresponding readings were taken outside the subway. The results of these observations are given in the Table appended, together with the maximum, minimum, and 9 a.m. temperatures at the observatory at the Nottingham castle.

It will be observed that the lowest reading in the open air at the Water Offices, outside the subway, was 19·2 on the 19th February, and the lowest readings in the subway, 40·7, 41·0 and 41·0 on the 16th, 17th January, and 19th February; the highest reading outside the subway was 53·4, on the 7th February, and the highest reading on that day in the subway was 45·8, so that for a range of temperature outside of 34·2, there was only a range of temperature of say 5° inside the subway, so that there is not the least chance, even with the present rigorous English winters, of the thermometers in the subways going down to anywhere near

Thermometrical Readings taken in the Subway, Albert Street; on the Portico of Water Offices, Albert Street; and at the Castle Museum.

Date.	Subway, Albert Street.			Water Offices, Albert St.			Castle Museum (The Green).			
	Max.	Min.	Pres. Temp.	Max.	Min.	Pres. Temp.	Max.	Min.	Pres. Temp.	Min. on Grass.
1892.										
January 13	48·0	42·5	..	39·1	27·0	..	39·2	23·7	34·9	24·5
„ 14	44·2	42·0	43·0	37·0	29·0	32·8	37·2	28·9	30·9	29·3
„ 15	44·2	42·0	42·3	34·8	28·0	30·8	32·8	27·0	27·8	26·2
„ 16	43·4	40·7	41·3	33·5	22·0	26·0	33·1	19·4	25·0	22·4
„ 17 & 18	43·0	41·0	42·8	37·3	25·4	36·0	36·9	23·8	36·9	24·5
„ 19	43·5	41·8	42·5	39·6	35·6	36·0	39·2	33·6	34·7	33·2
„ 20	43·2	41·9	42·4	37·8	33·0	34·5	35·8	32·0	33·3	31·5
„ 21	43·1	42·0	42·4	37·3	33·6	35·5	35·8	32·0	32·9	31·2
„ 22	43·2	42·0	42·8	40·7	34·5	40·0	40·8	32·0	39·3	30·9
„ 23	43·5	42·4	43.0	42·2	37·0	41·8	41·9	35·5	41·9	30·4
„ 24 & 25	43·8	42·8	43·2	45·6	35·3	38·4	46·1	35·0	38·7	29·7
„ 26	43·9	42·8	43·0	43·5	31·7	34·2	44·6	30·5	33·2	25·4
„ 27	44·3	43·0	44·0	46·5	34·0	46·0	46·1	32·2	46·1	30·7
„ 28	44·8	43·0	43·5	47·8	38·0	40·8	46·4	37·8	38·7	30·7
„ 29	45·1	43·7	44·3	52·5	35·4	52·0	52·8	37·8	52·8	36·7
„ 30	45·7	44·0	45·0	53·3	36·3	51·0	52·7	47·0	50·1	42·5
Jan. 31 & Feb. 1	45·8	44·3	45·3	53·1	40·6	47·0	53·3	40·2	46·1	33·8
February 2	46·0	44·0	44·0	48·3	34·0	36·8	48·0	33·5	36·5	29·9
„ 3	45·1	43·8	44·6	41·2	32·0	40·0	40·5	34·3	39·7	30·2
„ 4	45·3	43·2	44·0	42·1	30·0	33·5	42·5	28·4	32·2	24·5
„ 5	45·3	44·0	44·5	43·0	32·6	43·0	42·6	31·3	42·4	29·2
„ 6	45·3	44·2	44·8	46·0	37·8	42·7	46·2	39·6	42·1	30·9
„ 7 & 8	45·8	44·5	45·0	53·4	35·0	45·8	54·5	41·0	43·9	37·7
„ 9	46·1	45·0	45·4	49·3	38·0	44·5	49·1	35·2	42·9	33·5
„ 10	46·2	45·2	45·8	48·9	43·8	46·5	49·0	41·8	46·0	37·7
„ 11	46·6	45·3	45·8	49·3	39·0	41·5	50·5	37·3	40·0	30·7
„ 12	46·7	44·5	45·5	49·8	33·7	40·0	52·1	31·7	38·6	24·1
„ 13	46·5	45·2	45·4	46·1	36·8	40·0	47·7	35·8	38·3	30·3
„ 18	44·3	42·8	43·0	..	26·0	30·2	32·1	14·7	30·9	22·2
„ 19	44·4	41·0	41·8	32·8	19·2	25·6	33·1	13·0	22·8	16·7
„ 20	43·6	41·3	42·4	33·8	25·0	34·0	32·6	21·0	32·7	23·7
„ 21 & 22	44·0	42·1	43·0	42·1	25·0	39·0	42·3	31·0	37·6	29·7
„ 23	44·0	42·9	43·3	45·3	35·0	40·5	46·0	35·4	41·1	32·0
„ 24	44·3	43·0	43·3	46·2	38·8	40·0	46·9	36·3	37·9	36·2
„ 25	44·4	43·0	43·4	42·6	34·3	36·3	41·8	31·9	33·9	33·2
„ 26	44·6	43·0	43·7	44·6	36·0	37·3	45·0	31·8	35·2	32·7
„ 27	44·6	43·3	44·0	39·5	34·0	38·0	37·6	32·0	35·7	33·0
„ 28 & 29	44·7	43·6	44·2	43·8	36·0	39·0	42·1	34·4	37·7	34·1

freezing point. The minimum temperature at the observatory at the Nottingham Castle, on the 19th February, was as low as 13·0, showing what the temperature was outside the town.

As regards the cost of the subway, this is of course rather heavy; the cost of the subway proper, including side-entrances, sideways, and everything appurtenant to the subway itself, is about

10*l.* per lineal yard. This does not include the cost of the sewer, as this would be common to any method of forming streets with or without subways, nor does it include the cost of the concrete foundation for roadway. The vaults under the causeways cost about 20*l.* each, and there being vaults under each causeway they cost, therefore, about 12*l.* per running yard of the street; these vaults are let on a rental of 1*l.* each per annum, or 5 per cent. on the outlay. The subways proper cost about 3000*l.*, and there are 169 vaults, costing about 3380*l.*; 3½ per cent. interest on 3000*l.* is 105*l.*, but the profit on the vaults is 1½ per cent., as the money is borrowed at 3½ and 5 is charged, and this equals say 50*l.*, so that it resolves itself into this question, is it worth 55*l.* per annum to have subways in the two new streets referred to? The author thinks there can be only one answer to this question, and that must be in the affirmative. He does not urge that Town Councils should incur immediately a large expenditure of money on laying down subways in all existing streets, this would be impossible from its cost, but that in the case of new main streets and where main thoroughfares are improved and widened, that the opportunity should be seized to lay down subways, in order to minimise as much as possible the evils resulting from the continuous taking up and relaying of streets.

SEWERAGE WORKS: MANUFACTURING REFUSE.

It is not necessary at this meeting for the author to give any lengthened description of the sewerage system of the Borough, or of the Sewerage Farm, this subject has been somewhat exhaustively treated in a paper read by the author before a meeting of this association in Nottingham, in 1885, and also in a paper read by the late Mr. Tarbotton, at Hanley, in 1886. A reference to those papers will give all the information required on the subject, and will render it unnecessary for the author to go over the same ground again.

Attention was, however, called in those papers to one of the difficult problems which Borough Engineers have to face in some large towns, that is, what is to be done with the large amount of liquid and semi-liquid manufacturing refuse which is delivered from works where such processes as bleaching and dyeing are carried on?

The subject is one which is of considerable interest, and the author feels that no apology is needed for his bringing before this meeting a problem of this kind which has been recently occupying his attention and that of the Town Council.

The total sewage flow of the Borough in dry weather is about 6,125,000 gallons in 24 hours; of this quantity about 2,125,000 gallons per day gravitates down to the farm, and the remaining 4,000,000 gallons per day has to be pumped; the larger portion of the low-level sewage is brought down the Leen Valley sewer, and it is in the valley of the Leen where the principal difficulty regarding the manufacturing refuse is encountered.

The river Leen is a small tributary of the river Trent, is 13¼ miles long, measured along its course, and the area of its watershed is about 40½ square miles. The flow of this river of course fluctuates very much, according to the seasons; gaugings were taken in the early part of 1891, and the lowest was on the 15th January, which was 901,549 cubic feet, or 5,634,681 gallons per day, and the highest gauging, taken during a somewhat heavy rainfall, was on the 24th January, and showed a discharge of 6,162,976 cubic feet, or 38,293,600 gallons per day. The normal discharge of the river in ordinary weather would be from 15 to 16 million gallons per day.

On the banks of this river Leen, or contiguous thereto, there are about 24 bleach and dye works, of which number 17 discharge their waste waters into the River Leen, or into the tributaries and brooks, or into special surface-water sewers in connection therewith, and the remaining seven have been permitted to discharge their waste waters into the Leen Valley sewer previously referred to. The water used by the bleachers, &c., is not taken from the river Leen, but is pumped from copious springs in the magnesian limestone, in which strata water particularly suitable for bleaching and dyeing processes abounds in large quantities. The works are not concentrated in one particular district, but are scattered about in the valley of the river, and the distance from the uppermost works to the lowermost works, measured along the course of the Leen, is not less than four miles.

The waste waters turned into the river from these works is about three million gallons per working day when the local trades of lace and hosiery are fairly good.

The processes of bleaching differs in various districts according to the nature of the goods. The following, however, is the method adopted at one of the largest works in this district:—The goods to be bleached are first passed through cold water and then boiled in caustic soda (sodium hydrate NaHO) and crich lime; they are then run through a solution of bleaching powder (chloride of lime) and afterwards washed and run through a weak solution of sulphuric acid which is called "sours"; they are then boiled in carbonate of soda and soap, washed and run through chloride of lime, washed, and again run through "sours" (dilute sulphuric acid), and a final washing completes the operation. In some works strong liquor ammonia is used as an alkali instead of carbonate of soda, and in all cases of course very large quantities indeed of soap are used in the operations.

The chloride of lime in the waste waters effects a precipitation of the soap and other solids when these waters reach the river Leen, and the result is the accumulation of the offensive and noxious slime and mud on the banks of the river. The filthiness of the water and banks of the river appears to be an invitation to the residents on the banks to still further pollute the river by throwing in all manner of rubbish, &c. The existence of the various mills on the river tends to aggravate the difficulty and render the precipitation more effectual, as the damming up of the water to provide head for the water wheels forms a succession of settling ponds. To make matters still worse the river Leen does not deliver direct into a fast-flowing river of large volume, like the Trent, but enters the Nottingham canal, which flows through a densely populated part of the town, and does not reach the river Trent for upwards of two miles. In this canal, which is practically stagnant water, the deposition of mud and slime is continually going on, and in warm weather the nuisance is considerable.

On page 126 it has been shown that the normal discharge of the river Leen is from 15 to 16 million gallons per day, the discharge between 6 a.m. and 6 p.m., which would include the bleach and dye water would in round figures be about 9 million gallons; the waste water from the works is therefore about one-third of the total flow of the river between the hours named.

The problem is to effect the purification of the river, and the solution of this problem is not a very easy one. However, in reporting on this question to the Town Council, there appeared to the author to be three methods of solving the difficulty.

(1) To connect the bleach and dye works in the district with the system of sewers, and allow their waste waters to mix with the ordinary sewage and flow down the main intercepting sewer, eventually it would be pumped and delivered on to the sewage farm, and therefore purified by broad irrigation on land.

(2) To connect the waste waters from the works referred to with an entirely new and independent sewer, and conduct these foul waters to some convenient site and purify the same by precipitation and filtration.

(3) To compel owners of works to abstain from polluting the river, and put down on their own works a plant or apparatus for purifying their waste waters, either by precipitation or filtration, or both.

The first scheme would involve somewhat heavy engineering works, but nothing of any very particular difficulty; it would be necessary to increase the pumping plant at the pumping station, to provide an additional pumping main, and to buy about 225 acres of additional land at the sewage farm; this would make the total area of the sewage farm 1134 acres for say 9 million gallons of sewage per day.

The author is perfectly well aware that there are several very grave objections to this scheme; in the first place the 3 million gallons of bleach and dye water has very little if any manurial value; this, however, may be as truly said of the greater part of the sink washings from more than half of the property in the town; further, it was a matter of doubt whether the bleach and dye waters when mixed with the ordinary sewage would have any harmful effects on the crops at the farm.

Appended are analyses of waste waters from various bleach and dye works, and also of mud from the bed of the river Leen; these analyses were made by Dr. E. B. Truman, the Borough Analyst.

The acidity of the liquid expressed in terms of hydrochloric acid varies from 0·73 in No. 1 to 31·19 parts per 100,000 in No. 3; it will be noticed that the scouring suds in No. 6 contain a large quantity of alkali equivalent to 6640 parts of sodic carbonate per 100,000; it was presumed that this would counteract the acidity in the other samples when they were commingled together with the river water, and be rendered almost neutral; this was found to be the case, as on a sample of ordinary water from the river Leen being tested it was found to be only very slightly alkaline.

There remains, therefore, one chemical only which may be expected to be in any way inimical to vegetation, and that is the chlorinated lime; in one sample there is as much as 38·10 parts per 100,000.

The fatty acids are present in large quantities, especially in the mud, and when decomposed cause the offensive smell which emanates from the mud.

The presence of nitrogen in the waste waters is explained by the fact previously mentioned, that in some cases liquid ammonia is used in the bleaching processes as an alkali instead of carbonate of soda. The carbolic acid and nitrogen in the mud in such apparently large quantities can only be due to an exceptional discharge of tar and ammonia into the river Leen from the gas works.

—	Expressed in parts per 100,000.								
	Solids in solution.	Solids in suspension.	Total solids.	Acidity in terms of hydrochloric acid.	Available chlorine.	Equal to chlorinated lime.	Fatty acids set free by acidifying.	Carbolic acid.	Total nitrogen.
1. Waste water from mouth of pipe at Bleach Works, Vernon Road ..	147·2	51·6	198·8	10·22	10·65	38·10	50	..	8
2. Ditto from dyke near same works	151·6	83·2	234·8	0·73	6·74	24·13	15	..	8
3. Ditto from mouth of pipe at Bleach Works	123·2	80·8	204·0	31·19	·35	1·27	60	..	6
4. Ditto from dyke at same works ..	84·4	150·2	234·6	9·76	0	0	37	..	6
5. Dye and bleach refuse from main drain at Bleach Works, Bagnall ..	144·8	47·2	192·0	11·68	2·13	7·62	26	..	4
6. Scouring suds ..	708·4	232·8	941·2	alkaline*	0	0	418	..	4
7. Sediment from bed of Leen near Derby Road ..	..	..	467·62	neutral	free	..	108	250	200
8. Ditto from bed of Leen, near Grove House, beyond Outgang Lane ..	..	..	487·10	neutral	free	..	98	112	90
9. Ditto from bed of Leen above Mill, Ilkeston Road	..	..	385·68	neutral	free	..	154	386	100

* Alkaline equivalent to 6640 parts of sodic carbonate.

In order to thoroughly test whether the chlorinated lime and other chemicals in the waste waters would have any deleterious effects upon the crops when combined with the sewage, some interesting experiments were made; a quantity of average bleach and dye water was carted down to the farm, and after being diluted with twice its volume of ordinary sewage, the combined liquids were used on certain areas, and the effects upon the crops carefully noted and compared with similar crops treated with ordinary sewage only. The result of these experiments showed that there was actually no difference at all in the crops, and that the crops treated with sewage plus bleach and dye waters throve just as well as those treated with ordinary sewage only.

The second scheme proposed was to collect together the waste waters from the scattered bleach and dye works in the valley of the Leen by means of a new intercepting sewer, and purify these waters by precipitation in tanks, followed by filtration through filters of suitable construction. In the first place this scheme, although presenting no great engineering problems, would be very costly; it would have to be 4½ to 5 miles long, and in consequence of the nature of the strata through which it would have to pass the work would be rendered difficult. For a considerable length it would pass through silt and running sand full of water, and the remainder would have to be constructed in strata of the very hardest magnesian limestone, which could only be removed by blasting with dynamite; this rock is full of most copious springs, rendering continuous pumping a necessity. When brought down to the site of the precipitation works the whole of the waste waters would have to be pumped, and an area of land acquired of 12 to 15 acres for the precipitation works.

As regards the system of precipitation to be adopted the author went very carefully into this matter, and he came to the conclusion that it was quite as difficult to clarify and purify bleach and dye waters as it is sewage. It is popularly supposed, and when alluding to popular opinion, the author refers to the opinions expressed somewhat freely and always forcibly by some members of Town Councils (he does not, of course, refer to Nottingham), that to purify a million gallons of bleach and dye water it is only necessary to pour in a few bucketfuls of cream of lime, allow it to stand for half an hour, and the result will be a pure and clear effluent. This is very beautiful theory, but it is not practice. After numerous enquiries, the author had come to the conclusion that if a precipitation process were adopted it should be also combined with filtration, and that the best system of precipitation and filtration was that of the International Company, using ferozone as a precipitant and polarite as the filtering medium. Since writing this the author has had supplied to him the details of experiments made with the Salford sewage, and his opinions are somewhat modified; if the system last tried there (Lockwood's system) gives as good an effluent as is claimed by the patentee, it is a system which is worthy of trial, as it can be worked much more cheaply than the ferozone and polarite system.

The third course is to compel all owners of works to purify all their waste waters before they are turned into the river either by precipitation, filtration, or both. At the first glance it is quite natural to say, of course this is the proper scheme to adopt; it is waste of time to consider any other; put in force the provisions of the Rivers Pollutions Act 1876, and put a stop to the pollution of the river. This has not been found a very easy task in Yorkshire and Lancashire towns, and the author fears it would not be a very easy task in this town; there are several arguments which should be considered, they may not be peculiar to this town, but the points are worthy of careful consideration.

In coming to conclusions on all subjects concerning the welfare of the general public the author considers that Town Councils, so far as his experience goes, always approach a subject with fairness, and endeavour to treat manufacturers in various parts of a large town with equal impartiality, and not give those in any one particular neighbourhood any undue advantage or preference above those in another neighbourhood. There are a number of bleach and dye works in other parts of this town not contiguous to any river or stream. The owners of these works naturally discharge their manufacturing refuse into the sewers for the simple reason that there is nowhere else to send it; there are besides these a number of works contiguous to the river which have been permitted, a many years ago, to discharge their waste waters into the sewers. Now if extreme measures are resorted to with the owners who discharge into the river, in some of these works perhaps as much as 2000*l.* or more would have to be spent in capital outlay in building tanks, filters, &c., and a large sum of money spent annually in pumping the waste waters into the tanks, precipitation by some process with filtration through properly constructed filters. There would have to be the very strictest supervision by an official inspector, or the work of precipitation and filtration would not be done.

But these manufacturers would say, why should we be treated differently to others in the same trade? Why should we be handicapped in our trade? We pay the same rates as other people in the same trade, but are not allowed the same privileges and benefits. We will desist from polluting the stream if you will give us another outlet for our refuse. Looking at the question fairly, not from legal ground, but from an equitable point of view, the author felt that these arguments were somewhat unanswerable, and he recommended that these owners should be allowed to use the sewers for their waste waters.

In deciding between the other two schemes it was found, after carefully estimating the cost, that the precipitation scheme would cost about 14,000*l*. more than the scheme for taking the refuse waters down to the farm, and that the annual cost of the precipitation scheme, including 3½ per cent. interest on the capital outlay, would be over 2000*l*. more than the irrigation scheme.

The Corporation have a sewage farm, and it would only be necessary to increase the area and the pumping plant and simply extend their system which now works so well.

The land at the farm is eminently suitable for irrigation, and has a strata which is a natural filter, and which cannot be surpassed by any ordinary artificial filter. Further, in the estimate for the irrigation scheme is included a sum of 20,000*l*. for purchase of land. This outlay cannot very properly be compared with any outlay for works in connection with precipitation; the latter is not an available and realisable asset, the land is, and if any change of plans was contemplated and brought about, the land could be sold for possibly more than the outlay on it.

The points the author wishes to emphasise are these:—

(1) It is only equitable to treat all liquid, trade, or manufacturing refuse in any manufacturing town on exactly the same footing; and that where a number of manufacturers not adjoining any stream are allowed to turn their bleach and dye waters into the sewers, the same privilege should be accorded to the people in the same trade contiguous to streams, providing of course that such trade refuse does not cause actual damage to the sewers, such as would be the case from chemical works.

(2) That where a sewage farm is already available and in working order, the most economical method of treating and purifying these waters is to combine them with the ordinary sewage, and purify by broad irrigation.

EPIDEMIC HOSPITAL.

The old epidemic hospital was situated near the workhouse in the midst of a densely populated district; the buildings, which consisted of four large and four small pavilions, were wood-framed on brick foundations, covered on the outside with weather-boarding, and match-boarded on the inside, and having slated roofs. The outside woodwork was coated with tar, and was somewhat unattractive in appearance. The buildings were erected in about three or four weeks, during the serious outbreak of small-pox in this town in 1871; operations were carried on for 18 hours per day, Sundays included, in order to complete the buildings quickly for the reception of patients.

For 21 years this old hospital did valuable work in receiving cases of infectious disease, and, as temporary buildings, were successful; but very considerable difficulty was found in maintaining the wards at a proper temperature during very cold weather.

The fact of the buildings being situated in the densely populated part of the borough gave rise in later years to considerable apprehension on the part of the inhabitants of this district, and whether rightly or wrongly, they considered that the proximity of the hospital to their dwellings was a source of danger to them.

Dr. Thorne Thorne, Medical Officer of Health to the Local Government Board, in his report to that body on Hospitals for Infectious Diseases, in referring to the old hospital in this town, states that he made a thorough investigation into the question whether disease was spread from these hospitals, but "he was unable to find any case of this having been done."

One curious instance that danger from hospitals should not be based on isolated facts may be given: the old Hospital buildings were destroyed by fire, and some considerable time after there was an outbreak of scarlet and typhoid fever in a street contiguous to the hospital, which street had been free from these diseases while the hospital existed; had this happened vice versâ, that is, if there had been an outbreak of fever during the existence of the hospitals, it would have been put forward as being conclusive proof that it had spread from the hospital.

It was decided, however, in order to allay public suspicion, to remove the hospitals. It should be added, however, that one of the principal objects which was kept in view in removing the hospitals was to set free for building purposes, the piece of land on which they stood, and which at a moderate estimate was worth from 25,000*l.* to 30,000*l.* Having decided to build new hospitals, the great difficulty then had to be faced to find a site. No one appeared to want the hospital to be built near them. However, after long and protracted negotiations for various sites, it was found that the only one which the Corporation could bring to a definite conclusion on anything like reasonable terms was a part of the glebe land at Basford, the total area of which was 126 acres. They endeavoured to buy only a portion of this land sufficient for their purposes, and including a space of land for a large belt of trees round the hospital site, so as to secure as perfect isolation as possible, and prevent any complaints from neighbours. It was found, however, that the owner of the glebe land was unwilling to sell part of his estate unless he was compensated for the prospective injury which would be inflicted on the remainder of the land, and it was intimated that this compensation would be so heavy that it would almost equal the value of the land. This being the case it was decided to buy the whole of the land, about 126 acres, and the price agreed upon was 25,475*l.*, or about 200*l.* per acre. The area of about 5 acres, upon which the old hospital stood, is therefore worth as much or more than the total area of 126 acres bought for the new hospital.

The area fenced in and occupied by the new hospital is about 12½ acres, and the site is an exceedingly suitable and convenient one, the subsoil is a light sandy one, the site faces the south-west, and the distance from the market place is only 2¾ miles, but geographically it is only about 1 mile north of the centre of the borough.

At the outset the question of temporary versus permanent hospitals was discussed and fought out; it was urged by some that all the buildings for the reception of patients should be built of wood, and that they should be burnt down every four or five years; it was also gravely suggested that the ward blocks should be built of boiler plates, so that they could be disinfected by fire. The author of this idea did not state whether he would remove the patients before the process of disinfection was proceeded with. The Health Committee, however, acted upon the author's advice, and decided to erect permanent buildings.

The hospital buildings consist of the following:—Entrance lodge, administrative block, two blocks for scarlet fever, one for the isolation of certain diseases, one for smallpox with an annexe, a block containing the wash-house, laundry, and disinfector; and a block containing stables, mortuary, and sheds for ambulances, &c.

The administrative block contains on the ground floor—

Committee-room, waiting-room, matron's sitting-room, doctor's ditto, dispensary, two linen stores, matron's stores, nurses' dining and sitting-room, servants' ditto, kitchen, pantry, two stores, officials' laundry, and other out-offices.

On the first and second floors are bedrooms for the resident doctor, and for the matron, and also accommodation for about twenty-six nurses and servants.

The two scarlet fever blocks are exactly alike, and consist of entrance lobby, 18 feet by 10 feet, with stores on each side of entrance ; there are in each block two large wards, each 60 feet by 25 feet, and two small wards, each 13 feet 6 inches by 12 feet, called separation wards, for the isolation of certain cases; these rooms are all 13 feet 6 inches high ; the large wards accommodate ten beds each, and the small wards one bed each, the total accommodation in each of the fever blocks therefore being twenty-two beds. Between the wards is the ward kitchen, or nurses' room, 18 feet by 12 feet, with windows into each ward, so that the nurse can command a view of all four wards from the kitchen. At the end of each ward at one corner is an apartment containing w.c.'s and slop sink, and at the other corner a bath-room, with movable bath therein ; both of these apartments are cut off from the wards by lobbies with cross ventilation.

Outside the wards, near the entrance, are two stores, one for coals and one for foul linen, and a bath-room where the patient has his last bath, and can leave the hospital grounds without passing through any of the wards or corridors.

The whole of the walls in the blocks have a dado of coloured glazed bricks about 5 feet high, above that the walls are plastered with Parian cement on a ground of Portland cement. The first glazed brick above the floor is a coved brick—all the angles have coved bricks—and the jambs and heads to doors and windows are bull-nosed, so that practically there is not a corner to the walls in the ward. The floor is composed of specially selected red deal, laid in very narrow widths upon a counter-floor ; the floor is secret-nailed and polished.

All the windows in the wards have fanlights, which open back into an iron hopper glazed at the sides, and the windows are all double glazed. The system of heating is open fireplaces, supplemented by low-pressure steam ; in the large wards there are two of Shorland's grates and two circular steam radiators ; cold air is admitted by hit-and-miss gratings under each bed, and warm air in winter is admitted over each fireplace and through the two steam radiators; the bath-rooms and water-closets and entrance lobbies are also warmed by steam radiators, so that an equable temperature can be maintained in the whole of the block.

The only gas lights in the large wards are two Wenham lights with frosted globes, the products of combustion being of course carried away by a flue.

The system of ventilation is as follows:—over the ceiling of each large ward is a ventilating duct or channel of wood, lined with zinc, from 15 inches by 15 inches to 30 inches by 24 inches in size; in the centre of this, supported on iron brackets, are the flues from the Wenham lights; this ventilating duct communicates with a central tower. In the middle of this tower, which is 46 feet high, the smoke-flues from the ends of wards, and from the ward kitchen are carried, and the space round same is the foul-air flue for carrying off the foul air from the wards; at the point where the ventilating duct over the wards joins the central tower there are two large and very powerful Bunsen burners, which materially assist the ventilation and tend to destroy the germs in the air. The cubical contents of each ward is 20,250 feet, and the floor space 1500 square feet; this gives 2025 cubic feet per bed, or 150 square feet of floor space per bed; the window space (that is, the actual area of the glass) is a little over $\frac{1}{7}$th of the area of the floor, or $\frac{1}{90}$th of the cubical contents. These calculations are based on the assumption that the beds are occupied by adults; as a fact the average age of the inmates has been found to be only about seven years, and it has been proved to be quite practicable to increase the number of children in in each ward to 17 or 18.

The isolation block contains sixteen beds in six wards; four of the wards are 18 feet by 16 feet, and two wards 32 feet, by 18 feet, and they are connected by an internal corridor 90 feet long and 7 feet wide. This block has a ward kitchen and is constructed, heated, lighted, and ventilated similar to the scarlet fever blocks. The smallpox block is exactly similar in size to the scarlet fever blocks, and has accommodation for twenty-two beds; there is added, however, in this case an annexe containing nurses' day-rooms and bedrooms, so that nurses tending cases of smallpox need not use or live in the general administrative block and so mix with nurses who are attending patients with other diseases.

The laundry block contains boiler-house, engine-room, wash-house, drying-room, and ironing-room, with the usual machinery and appliances, and also a disinfector. The adjoining block of buildings contains the stables, sheds for ambulances, and the mortuary.

The various blocks are connected to the administrative block and to each other by telephones.

The administrative block and four blocks as described are connected together by means of corridors 6 feet wide, which have a dado of glazed bricks, with Parian cement above same; a carriage-drive leads up to the doors of the wards, and this forms a "blow-through," and practically cuts off the corridor from the wards.

The walls of the corridors are carried down sufficiently deep to form a basement-floor, and this is divided into two compartments; one side is used for gas and water pipes, and the other side for the steam pipes; the whole of these pipes, therefore, can be examined, repaired, or replaced without disturbing the surface. From the end of the existing corridors to the boiler-house, a small subway is constructed to receive the pipes.

The boiler supplies steam to the two laundries, and also to the kitchen for cooking purposes.

The drainage received very careful attention, and is laid on modern principles; ample means of ventilation and flushing are provided, and all the pipes have Hassall's patent joint.

There is sufficient space for four additional blocks to be built without any overcrowding whatever; the administrative block is 130 feet away from the main road, and there is a space of 110 feet between the sides of the blocks, and about 80 feet between the ends of the blocks.

The buildings are at present filled to overflowing with scarlet fever cases, of which there are now 157 under treatment; about 80 per cent. of the total cases notified are removed to the hospital. Since the opening in October last, no less than 471 cases of scarlet fever have been received, and of this number only 3 per cent. have died. This speaks well for the care bestowed upon the patients by the medical staff and nurses, and shows also that the buildings are erected on true sanitary principles.

PUBLIC HEALTH ACTS AMENDMENT. SOME SUGGESTIONS IN RELATION TO PRIVATE IMPROVEMENTS.

By WM. SPINKS, Assoc. M. Inst. C.E.

Since we last discussed the question of Private Improvements in 1886 the author has had a great deal of correspondence, not only with surveyors and clerks to urban authorities, but also with property owners and agents, and many of the cases they have brought under his notice have occurred to him as being worth recording; and, in addition to this, during the past five years we have had a considerable influx of new members, and it will be well to ascertain the experiences and opinions of the new blood before any attempt is made to recast the sections of the Public Health Act which deal with Private Improvements. As the Council have invited the co-operation of members in the work they have in hand, the author for this purpose has revised the remarks he made in 1886 upon "Suggested Remedies for the defects of the 150th Section Public Health Act, 1875," and extended them in the directions dictated by the experience he has recently acquired.

Most surveyors in their practice in carrying out the section have met with cases that are not apparently provided for, and which, being recurrent, it would seem to be desirable for legislation to be enacted, so as to embrace the most important points. Of course it would be impossible to frame an Act of Parliament to meet all the exceptional and unusual cases, and one that would justly satisfy the various interests and parties involved.

In the author's opinion reform is required in the direction which is hereafter pointed out.

Street.

The interpretation of this term should be made still more clear, and should include any road dedicated to the use of the public, whether built upon or not, even if it is not in the ordinary and popular sense a street. A road may be an important thoroughfare, largely used, and in a deplorable condition so far as the surface is concerned, may be confined within walls or other fences, and fronted by agricultural land. There should be no doubt as to the powers for dealing with cases of this character.

Boundaries.

In some instances roads have boundaries running down the centre, crossing them diagonally, or along the building line; possibly the adjoining authority may be a rural one. The present method of dealing with these cases is by mutual agreement. For the purposes of private improvements a street of this character should be placed under the exclusive management of one of the authorities, who should be able to deal with it precisely as if it was wholly within the district of that authority, and they should have the same rights against the frontagers for the recovery of expenses as if the whole street and premises fronting, adjoining, or abutting, were entirely within the district. These conditions obtain within the area governed by the Metropolis Management Acts, and appear to be a sensible provision, and the most satisfactory that could be made.

NOTICES.

It will be generally admitted, and the cases that have been before the courts prove, that the present method of service is altogether unsatisfactory and unreliable, however great pains may have been taken to be precise. The Manchester method of publication is by posting in the street and advertising in the newspapers, the posting being witnessed a given number of times, and a copy of the bill and advertisement being endorsed and filed for proof of publication if contested. This is considered sufficient notice to the owner, and the system might with advantage be made universal.*

* From 'Manchester Guardian,' 16th May, 1891.

CITY OF MANCHESTER TO WIT.—6th day of May, 1891.—It is this day resolved and ordered by the Council of the City of Manchester that the following street and part of street, being now formed and set out within the city of Manchester, and not sufficiently drained, levelled, flagged. and paved to the satisfaction of the Council, viz.:—

Township of Crumpsall: Oak Road (from Crescent Road to a point 116 yards distant in a northerly direction);
Township of Rusholme: Heald Place,

There should be no option in the notice as to who should do the work. The system of allowing the owner to do it is bad, besides being impracticable. It is impossible to complete half a street. How can a man lay half a sewer, and what sort of a surface would there be if each half was laid at different times? The specification on the notice should be comprehensive and exact, and state the whole of the intended works required by the authority to be carried out, and they alone should carry out the work accordingly, and be responsible for its due and proper fulfilment.

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shall, within four months now next ensuing, be FREED from OBSTRUCTION and DRAINED, LEVELLED, FLAGGED, and PAVED or otherwise completed with Footways, Gutters, and Drains, and in the following manner, that is to say—that the footways of the said street and part of street shall be flagged with Rochdale or other flags of approved quality, at least three inches thick, and that the curbstones be not less than eight inches thick and twelve inches broad, all properly squared and tooled, and laid with proper inclinations; that the curbstones for cellar windows shall be of Rochdale or other stone of approved quality, ten inches broad and six inches thick, squared and tooled on three sides, the grids to cover the window openings to be of cast iron sufficiently strong; that the carriage-way of the said street and part of street shall be paved with grit setts from the Rakehead quarries, not less than six inches deep, or otherwise paved with such setts or other materials as the Council shall approve; that the foundation or bottom for the paving shall be twelve inches thick, and composed of gravel or broken stones and cinders; that the crossings shall be paved with proper setts, that the drains shall be formed of well-burned firebrick tubes, or of such other materials as the Council shall approve; that there shall be circular eyes upon the sewers and the surface drains, with iron grids at the channels, constructed of such strength and sizes and at such distances as the Council may direct; and that the whole of the materials and workmanship shall be subject to the examination and approval of the Council or their proper officers.

WM. HENRY TALBOT, Town Clerk.

I do hereby give notice to all parties interested that if they shall respectively neglect or refuse to FREE from OBSTRUCTION and DRAIN, LEVEL, FLAG, and PAVE or otherwise complete the street and part of street mentioned in the above order of the Council of the City of Manchester within the period and in the manner required by the said order, that the said Council will cause the same to be done, and, in case of failure by the owners to pay on demand the costs and charges to be thereby incurred, will recover the same from them by distress and sale of their goods and chattels, or otherwise according to law.—Dated this 8th day of May, 1891.

WM. HENRY TALBOT, Town Clerk.

N.B.—A plan and section of the above street and part of street may be seen and all other necessary information obtained by applying to Mr. JOHN ALLISON, the City Surveyor, Town Hall, Manchester.

CHARACTER OF THE WORKS REQUIRED TO BE DONE.

At the present time it is customary for an authority to adopt a hard and fast line throughout its district for the method of completing private streets, without any regard to the character of the property abutting on to different streets, or to the necessities of such streets. Such a system is manifestly unfair and absurd. Happily the author has got an illustration of how this system works in a suburb of Manchester, and the accompanying Diagram I. (p. 154) can be explained as follows: *Streets Nos.* 1 are wide streets leading from one populous district to another; they are much traversed, and partially fronted by shops. *Streets Nos.* 2 are short cross streets, fronted by small houses, having no vehicular traffic but costermongers' carts, doctors' carriages, &c. *Streets Nos.* 3 are *culs-de-sac*, fronted also by small houses. *Streets Nos.* 4 are roads and avenues, fronted by detached and semi-detached villa residences. The whole of these roads are apparently completed exactly alike, the surfaces flagged and paved, whereas the surface of the main road is macadamised. The common-sense view to take of cases like these is that each street should have been dealt with according to its necessities.

No. 1 being streets which are main arteries of traffic, and means of communication between one populous locality and another, or are fronted by important property, require strong foundations and durable surfaces, the materials and workmanship to be of the best throughout.

No. 2, being streets which run crosswise between main thoroughfares and only having light traffic, or are fronted by cottage property, require lighter foundations and less excellent surfaces, but these, on sanitary grounds, should be impervious.

No. 3. Courts, alleys, culs-de-sac, passages, &c. These should be formed with impervious surfaces, such as flags or asphalte.

No. 4. Roads amongst better-class residential property, such as suburban roads and avenues in parks, &c. Having regard to the quality of the property and the convenience and comfort of the inhabitants residing on this class of road, it might be desirable to complete these surfaces with macadam, asphalte, or gravel.

The author is aware that the foregoing suggestions are surprisingly radical and a complete reversal of present methods, and that some may see difficulties in administering such powers. His proposal is that each authority should declare that they will divide all incompleted or intended private streets into four such classes, and then to fix the standard of materials and finish required in each class. Of course there would be many objections to a body of citizens fixing for their fellow citizens such standards, inasmuch as committees are so subject to outside influences and pressure as well as being guilty of sympathy with suffering property owners, and oftentimes the "outs" become the "ins," followed by a ruthless reversal of policy. To obviate all this, an impartial tribunal is suggested, such as an Inspector of the Local Government Board, who, after the declaration by the authority, should hold a public inquiry, and after viewing the character of the streets of the district, take evidence as to the most suitable materials the locality afforded, and then fix the respective standard for each class of street, and which should afterwards be adopted throughout the district.

If after publication of notice to do the work the owner objected and considered the works excessive, an appeal to the magistrates, assisted by a professional assessor, would decide under which class the particular street in question would come. The great object should be for an authority to arrive at a satisfactory understanding with the owners before the works are commenced, and thus prevent disputes arising after completion which ought to have been cleared up at the outset. At the present time the owner is rather arbitrarily dealt with, having no remedy until Section 257 comes into operation, and some such suggestions as the foregoing if carried into effect would afford him all the protection which is rightly his due, and by proceeding in the manner described there would be no difficulty in doing this equitably between the parties, as both the proposed courts would be open and impartial, and their decisions would only be arrived at after hearing and weighing the evidence of both parties. If it were left to the owner to have the right of appealing against the proposed works on the grounds of their being unreasonable, then appeals would be incessant, because there are so many owners who consider the interest of their own pockets as paramount, and not the comfort and health of the inhabitants occupying their houses; and to this class of men a cartload of gravel or ashes spread on a street makes it a reasonable surface, and any expenditure beyond that he looks upon as downright extravagance. And again, amongst cottage property where the poor live it is a very common custom for the tenants to throw their slops and waste water straight out of the door on to the surface of the road.

It must be remembered that, in large towns especially, the street is after all the playground of the children, amongst whom, unfortunately, in our manufacturing districts the death rate is so abnormally high. A child with its nostrils so close to the surfaces breathes and inhales mephitic odours arising therefrom, which at the height of an adult person become dissipated in the air; so that on sanitary grounds it is imperative that the surfaces of this class of streets should not be precipitating tanks nor filter beds, but should be clean, dry, and impervious.

It may also be urged that to classify the quality of the surfaces of streets would inflict undue hardships on property, and would be inequitable in its incidence; but on the other hand it must not be forgotten that when a man takes land for building purposes on a main thoroughfare he generally does so with an eye on the "main chances," knowing very well that the traffic and the business it brings all tend to enhance the value of the property when erected; consequently it is better able to bear the increased burden of superior roadmaking.

Estimate and Preliminary Apportionment.

The estimate of the contemplated works which is prepared by the surveyor for deposit along with the plans and notice should also include an approximate apportionment of each owner's share, according to his frontage or whatever method of assessing is finally decided upon as being the most equitable. It is a popular notion now that each party pays the exact amount of work executed from the building line to the centre of the road co-extensive with his property, and a stipulation that he shall do so is frequently met with in leases.

To prepare separate accounts for each block of property would entail an enormous labour on the surveyor, and if the various items were particularised the methodic owner would go out on the ground with his tape and rule and check quantities in his own style, which would naturally result in differences, interminable disputes, and demands for amended estimates.

Partial Works.

It would often be a great convenience to a locality if parts only of a road could be dealt with and taken over by the authority on completion. For instance, a road may be an important one as a thoroughfare, but only sparsely built upon; and there may be no pressing necessity for flagging the footways, which would be a useless expense to the frontagers of vacant land, but the paving of the carriageway would be a great public advantage.

The author had such a case which urgently required dealing with. The authority felt in the first place that in the present state of the law there would be some risk in the recovery of the expenses; and in the second place, that to require the frontagers to complete it in accordance with the Act would be dealing harshly with them. The road was a long one, and about $\frac{19}{20}$ths of the frontage belonged to the ground landlord, who had declared his intention to resist the enforcement of the Act. The road has lately been completed by arrangements and concessions on both sides.

Method of Executing Works.

Another question about which there is a great difference is the procedure observed in executing the works. Some authorities do the works themselves with their own staff, while others let all work by contract, after publicly advertising for tenders. The former system is open to grave abuses, entails more labour on the surveyor and his office staff, and nearly always gives dissatisfaction; whereas the latter system is fair and above board, and removes ground for complaint as to the works being too costly or above market price.

Sewers.

It would be much simpler and more satisfactory if the costs of all sewers were charged direct to the district rates. The clean water that comes into the town does so in pipes, the costs of which are charged to a common fund, but immediately the water is fouled and becomes sewage, the owner of the property has to provide means of carrying it away so far as is coextensive with his premises. The reasons for this anomaly have never been made clear. If the authority alone was responsible for the construction of sewers, surveyors would not feel hampered in designing them for private streets, nor would the question as to how far the sizes are reasonable ever be raised. If it should be found impossible to revise the existing system, powers should be given to an authority to contribute, if necessary, towards the costs of sewers in certain cases, that is to say, if for the purposes of a sewerage scheme it is desirable to construct an intercepting or trunk sewer in a private street, then the excess costs of such a sewer over one sufficient for the requirements of the street itself should be borne by the authority. The author had a case of this sort in a road running along the boundary of one portion of his district, and this course was followed. It should also be made plain to the surveyor that he must only design sewers sufficient for the necessities of the street he is dealing with. The author knows several cases where sewers have been made as large as 3 feet by 2 feet, when by no possibility could more sewage enter than would be discharged by a 9-inch pipe, and the defence for this has been that it is customary in the district to build sewers large enough for a man to traverse. Such reasoning is ridiculous, and the costs incurred through such ignorance should be thrown upon the right shoulders.

The size of the sewer does not, so long as it is adequate for the duty it has to perform, in any way enhance the value of the property, and to expend money in sewers excessive in size and beyond actual requirements, is wasteful, and an imposition upon property owners.

There is one more difficulty with regard to sewers, and that is the character and condition of old sewers which may be met with in private streets. Frequently when estates have been first laid out for building purposes, sewers have been put in by the grantors of the land; in many cases these are large, loosely constructed, sufficient perhaps to carry off the drainage, but without manholes or ventilation, and altogether inconsistent with modern ideas of what a proper sewer should be, both as to form and materials; they may also discharge at undesirable points, and may otherwise be incompatible with a drainage scheme for the district. Although the property owners may have taken to the sewer in good faith, and repaid to the parties who laid the sewer the costs of so doing, yet they should not be relieved of the responsibility of constructing another satisfactory sewer at the instance of the authority, if the surveyor, as their professional referee, advises that from structural or other reasons it is inadvisable to adopt the sewer found in the street. In many instances authorities are very diffident about dealing with these difficulties, because of the hardship it imposes upon property owners in having to pay for some work twice over, and they are content to take the risk of adopting an indifferent sewer. The surveyor should be the sole arbitrator in these matters, and his decision should not be placed under review by any court, as these questions of scientific knowledge cannot well be decided except by experts.

Levels.

Where parties have erected houses and fixed the levels without the direction of the surveyor, and in consequence thereof the street level has to be so adjusted that underpinning, the raising or lowering of abutting streets, &c., may be necessary, then these costs should be a charge solely upon that particular property, and cannot in fairness be charged to the total expenses of the street or to the district rates.

Frequently in altering the level of streets it may be necessary to alter gas or water mains.

By the Clauses Acts of 1847, the only parties who have power to do this are the undertakers and the authority, and one or other must bear the cost. The undertakers in the first instance may have come upon the road when it was simply marked across a field, and laid their mains under the sods without any reference to future levels or requirements, or perhaps without consulting the surveyor thereon. When the authority comes to deal with such cases, they are acting in default of the owners, and as if they were their agents; it is manifestly unfair that such charges as will be incurred in altering these pipes should be borne by the district rate, they ought in all fairness to be part of the works of making good, and charged accordingly.

Occasionally streets may have banks sloping to them or from them. The author had a case of a road where on one side was a high bank sloping to the road, the sides of which continually slipped down. The owner objected to slope it off to a proper inclination, because he contended that to do so would rob him of so much land at the top level, which he might reserve if he built a retaining wall, and which he was not disposed to do at the time the road was being formed. Under the Act there is nothing to control this, and it appeared the case could not be dealt with until the road was declared a highway, repairable by the inhabitants at large, when a prosecution at common law for an obstruction could have been instituted. The converse case to this is sometimes met with, where it is necessary for the support of the road, either that the bank should slope from it, or that a wall should be built to support it, and the frontager may object to either or both of these methods, and in one case brought to the author's notice the land on the low side of the road was not in the same ownership as the soil of the road, consequently the wall had to be built under the footway.

These cases may not often occur, and probably only in hilly districts, but when they do they occasion considerable trouble as to how they should be dealt with and the costs borne; it is necessary that some provision should be framed which will deal with them fairly to all parties concerned.

Power to Enter Private Streets to Repair.

It would be well if power were given to an authority to enter upon private streets to repair them, after giving notice to do so, and to recover the costs from the respective owners. Very often there are cases where it is not altogether necessary to carry out such extensive works as would be required under the notice to form and pave, &c., and where the owners cannot be prevailed upon to combine to do the repairs; a little judicious expenditure may sometimes meet the immediate necessities of such cases, and render the roads perfectly satisfactory to the authority.

Where land is laid out for building purposes, and the streets marked out, power should be given to control the character of the material used in forming the street up to the proper level, or that may be used in filling excavations caused by the removal of sand or gravel, &c.

Similar powers to these were obtained for the Metropolis in 1890.

Measurement of Frontages.

In measuring frontages the vexed question of the intersection of cross streets always crops up, and will do so as long as it is left permissive as to how the apportionment is to be made. The plan of measuring the frontages net, and apportioning the costs of the intersections over the whole area, is the simplest if not apparently the most satisfactory method, and it would cost far more than the amount involved for any frontager to contest the fairness of the charge. A reference to the case of *Burnley* v. *Schofield* will explain this method of apportionment very clearly. To try and settle these costs by apportionment upon the frontagers according to the consequential benefits received, would be well nigh impossible.

As an illustration, in Diagram II., the street, 14 yards wide, has to be paved for a certain length, but terminating at B D; the cross street, 10 yards wide, remains unpaved, and likely to be so; all these adjoining streets have an equal user of the area A B C D, and the question to decide would be, how far in each direction (other intersections being adjacent) will the benefit of that user extend, and in what proportion are the expenses of completing the intersection to be borne? In Liverpool it is the custom to charge the costs of all these intersections upon the rates, and the amount so expended in any one year would never be a serious burden in any town. To show the equity of this system, and the difficulties that arise under the present one, a diagram (No. III.) is here given of a case that recently came under the notice of the author, and which is by no means uncommon, all the three streets being private streets made good at different times.

The question would be, who is to pay for the plot included between A B C, and who is to bear the expenses for the frontages A B, B C, A C? To measure either A B, A C, or B C in with the crossings and the frontages net, would be an unfair burden upon the owners adjacent, and as the acquisition of such an open air space to a township is a great gain, the charge of the costs of the plot included between D, E, F would not be a great infliction for the district rate to bear, and is clearly the most equitable solution of the difficulty.

Frequently streets intersecting at angles greater or less than right angles, have the corners rounded off, and the measurement of such frontages at present offer difficulties to a surveyor. It was the author's custom, in cases similar to that shown in Diagram IV., to measure to the centre of the curve from x to x, but the point is fairly open to question, and is one that requires definite instructions as to its settlement.

CONSEQUENTIAL BENEFITS.

The whole of these last cases, as shown by the diagrams, raise the question as to the soundness of the present method of apportionment by frontage. There are also another class of cases bearing upon it, and those are with respect to premises not fronting or abutting upon the street to be apportioned, but which have access thereto, and enjoy a consequential benefit from the works of making good, as the following instances amongst others will show. It is customary to measure all frontages net, with the exception of passages and entrances to courts, one-half of which is charged to each adjoining property having frontages to the street to be apportioned. This is open to objection, for frequently there are properties enjoying the use of the entrance to the passage, but having no frontage to the street which is being made good.

A reference to Diagram V., which is a representation of an actual case, will show that whereas A and B only are liable for payment, all the other properties, C, D, E, F, G, H, and K have the use of the entrance between A and B, and access over the street, which is their only access to the back part of their premises.

Sometimes there may be workshops or livery stables or other premises having access to the street, as shown in Diagram VI.

Diagram VII. illustrates a case which came within the author's experience. A private street leading out of a main road required making good. It was only fronted by cottages; at the far end was a road to a colliery, which, having bad gradients and unsuitable connections with main roads was very little used; consequently, the colliery carting was done over the private road, and when the apportionment was made they could not be made to pay, and an excellent road was made for them at the expense of the cottage owners. The same thing may occur in cases of *culs-de-sac* having gateways at the end which several premises may have the use of. Thus these and similar places by their traffic cause the carriageway of what for the requirements of the immediate property would be a fair and satisfactory street to be cut up and rendered impassable, and bring down the authority upon the owning frontagers with the powers of the Act; and when the works are completed these destroying angels get off scot free, and carry on their business with greater convenience and economy.

RAILWAYS AND CANALS.

While there are undoubtedly premises not fronting to the street which enjoy a consequential benefit from it, there are on the other hand premises which may front it and which by no possibility can enjoy any consequential benefit; these are in certain cases railways and canals. A great deal has from time to time been urged about the hardship of compelling railways and canals to pay according to frontage. Certainly when railways are on embankments or down in cuttings they cannot derive much, if any, use from the formation of the street, but roads may be a means of communication to their stations or depôts, and if they can be used when carrying thereto or therefrom, or by the companies in carrying on their business from which they derive a revenue, then they ought to contribute towards the cost of completing such roads, which also may very likely in many cases when they are made good reduce the distances to their depôts, and provide another and shorter means of access to them, and a good and easy road for the traffic; and further, if the railways and canals are upon the level of the street a use can possibly be made of the road at a future time by widening on the side of the line distant from it, and by placing wharves, &c., abutting on the street. Certainly, where main lines not in the vicinity of any station either on an embankment or in a cutting abut on to a street, it can be of no possible use to them, and the companies should not be called upon to contribute to the cost of its formation. There are many cases of *culs-de-sac* formed abutting on to such railways, and the payment for frontage under such circumstances is clearly anomalous. The provisions of Section 3 of the Metropolis Management (Amendment) Act, 1890, appear to be equitable, and the application of them to new streets would meet the difficulty.

CULS-DE-SAC.

The owners at present having the option to do the work is likely to cause injustice in cases of this sort, as will be seen by a reference to Diagram VIII.

Upon receipt of notice to do the work, A, B, and C combined to complete the plot contained between 1, 2, 3, and 4, consequently their expenses were much less than if they had been rated along with the other frontagers.

Streets of Varying Width.

Some method should be devised that will remove the present injustice of charging in streets of varying widths the owners of premises in the narrow portion a share of the costs of the works in the wider portion, and which relieves the owners in that part of a considerable amount of their proper burden. For instance, a street may have a long length of uniform width of fourteen yards, and a short length of twelve yards wide; it is certainly unfair for a frontager in the latter portion to contribute a fraction to the excess width in the wider length, although it is contended at the present time that he has a right of user over it, and enjoys the benefits which accrue to his property from the access over the wider road.

Apportionment by Frontage Inequitable.

At the present time the Surveyor in making his apportionment has to exclude from his purview every consideration except the one of frontage, and this system is clearly shown to be defective, as it fails to embrace premises, except in a minor degree, which may have their sole right of access by the road in question, and which may enjoy far greater benefits from its being made good than the actual frontagers. The term consequential benefit is somewhat vague, and a system of apportionment should be devised that will reach in a clear and well-defined manner, the whole of the parties to whom the road is beneficial, and cause them to contribute their proper proportion so as to avoid the chances of going to arbitration upon the extent of the area to be included within the zone of consequential benefits.

Apportionment should be according to the Rateable Value.

In the author's opinion, after an experience of all classes of roads, the most just and equitable system of apportionment would be upon the rateable value of the property fronting to the road or adjacent to it, and having access to it and using it for the purposes of the business carried on in the premises. An exception to the rateable value basis should be made in the case of vacant land which is maturing for building purposes, and which so to speak is lying dormant with one eye open upon the unearned increment. For the purposes of private improvements, land of this character should be assessed upon its capital value. A very good comparison of the two systems of apportionment can be made by reference to Diagram IX., and which is an actual case within the knowledge of the author, and one that led to a great deal of strong feeling at the time notices were served, and litigation after the apportionment was made.

At one end of this road was a main line of railway, with passenger station on a branch line; the road was the only means of access to the station from a populous district. On one side, abutting on the railway, was a large engineering works, having no other outlet except on this road. On the opposite side was another engineering works, having a frontage also upon another road. The agricultural land was on the top of a sloping bank about 15 feet high, and the frontage to this road added no value whatever to the land. The quarry when filled up would make building land. There was also a long irregular strip of vacant land between the road and the boundary of the district; this land was too narrow for building purposes, and was absolutely valueless. The other plots speak for themselves. This is a very good example of the inequity of apportionment by frontage. Plots of no value, and to which the making good of the road would add no value, contributing out of all proportion to the benefits received, to make a road for the enjoyment and advantage of large concerns who could well and justly afford to pay more reasonably for benefits received, and more especially does this apply in the case of the railway station. The equity of apportionment on the rateable value basis in cases like this must be very obvious; of course when property is of a similar type and value throughout, one system is as good and as fair as another.

INCIDENTAL WORKS.

The legalising of the addition of the costs of incidental expenses as part of the charges for making up the street is necessary, and should include costs for searching for and examining sewers, advertising, inquiry expenses, and say, 5 per cent. for surveying, plans, superintendence, and office charges, but no charge for quantities, except by arrangement. Many works are extensive, and must necessarily extend over a long period of time, consequently a considerable sum of money is incurred in interest on the money advanced for payments on account. Under the present law this money if paid must be provided out of the rates, and cannot be recovered from the owners. This should be rectified, as the owners, if doing the works themselves, would certainly have to find the money from time to time for payments, and consequently to pay interest for it; the same argument will apply to the 5 per cent. charge for the superintendence, &c., as the owner would have something to pay in case he did the work himself.

RECOVERY OF EXPENSES.

The recovery of expenses summarily on completion of the works is often a very great hardship upon the owners of cottage property, especially when they are working men who have invested their savings with the assistance of a building club. On the other hand, the system of spreading the repayment over a long series of years is also objectionable; at any rate the limit should not exceed ten years. The demand for the whole sum should be made at the proper time, and then if there is any demur to payment, the special circumstances of the particular case should be inquired into, and if there is any hardship in enforcing payment for the whole sum, an arrangement can be mutually entered into, fixing a given term of years—thus each case would be dealt with on its merits.

CONCLUSION.

The administration of the existing laws has proved the need there is for a reconstruction of them, and the foregoing appear to the author to be the most salient points upon which remedial legislation should be based. Members of the Association must bear in mind that there are two sides to this question, and that owners of property, either individually or through their Associations, will take care to have their views properly represented before Parliament. Still, the opinions of a body like this, comprising as it does some of the most experienced of men in municipal engineering, will have great weight with the framers of a new measure, and when we remember what a large number of cases have been before the courts even since we last discussed the question in 1886, we cannot but come to the conclusion that it is quite time some further attempt should be made in the direction of an amendment of the Public Health Act of 1875, so far as relates to Private Improvements. When last it was under review by Parliament, as a body or individually we did not take quite as active and prominent a part in the work as our positions and experience entitled us to do, and it is with the object of reviving your interest in this, not the least important branch of your practice, that I have ventured to reopen the question to-day.

DISCUSSION.

Mr. Eachus: In order to save time I will propose a vote of thanks to the authors of the papers for the valuable information they have given this meeting. With reference to Mr. Brown's paper, we have had the advantage of seeing the works to which it refers. The first portion of the paper referring to street subways is particularly interesting to us, inasmuch as those subways are not very much in use up to the present time. We had the privilege of seeing how the work was done, and on the ground we heard a few more details which are not given in the paper. I think I am right in saying that no charge is made for any telegraph, telephone, or other wires fixed in those subways, and that the only charge made is for the cellars. That seems a very liberal way of dealing with the matter, and one likely to lead to an extension of telephones and electric lighting. With reference to the sewage works, although we are informed that there are a great many bleaching and dye works, I did not see any discoloration in the effluent water leaving the farm. I happen to have a sewage farm adjoining one with a single crape works, and I am bound to say the effluent coming through my district is very often discoloured by the crape works. With reference to the advice given by Mr. Brown to his Corporation, I think he has advised the right thing. The county town of Nottingham has a large sewage farm available from which they are able to turn out a very good effluent; and the only thing one would like Mr. Brown to add to this portion of his paper is some information as to the cost of, and returns from, the sewage farm. My own experience has been that if you have land which can be treated with sewage so as to get a

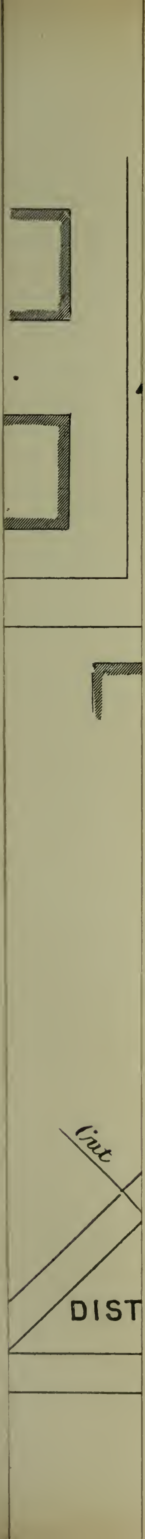

DIAGRAM II.

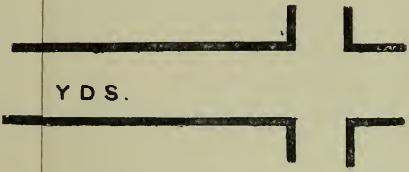

DIAGRAM III.

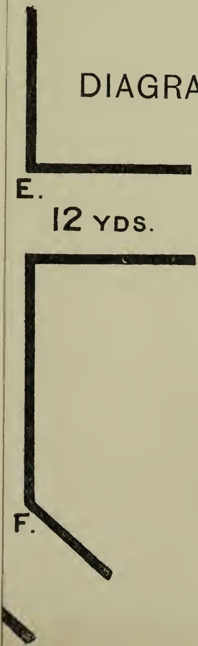

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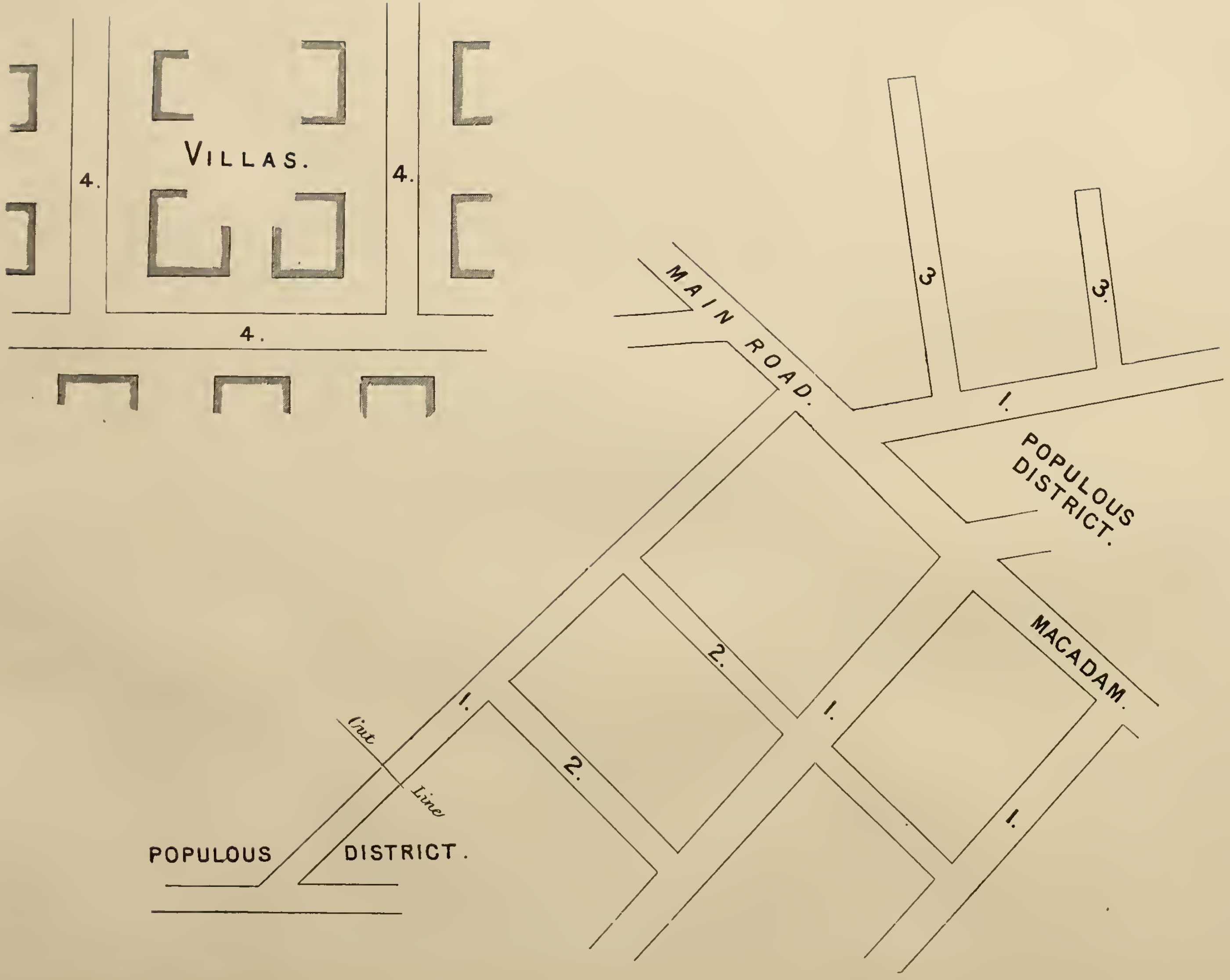
DIAGRAM I.



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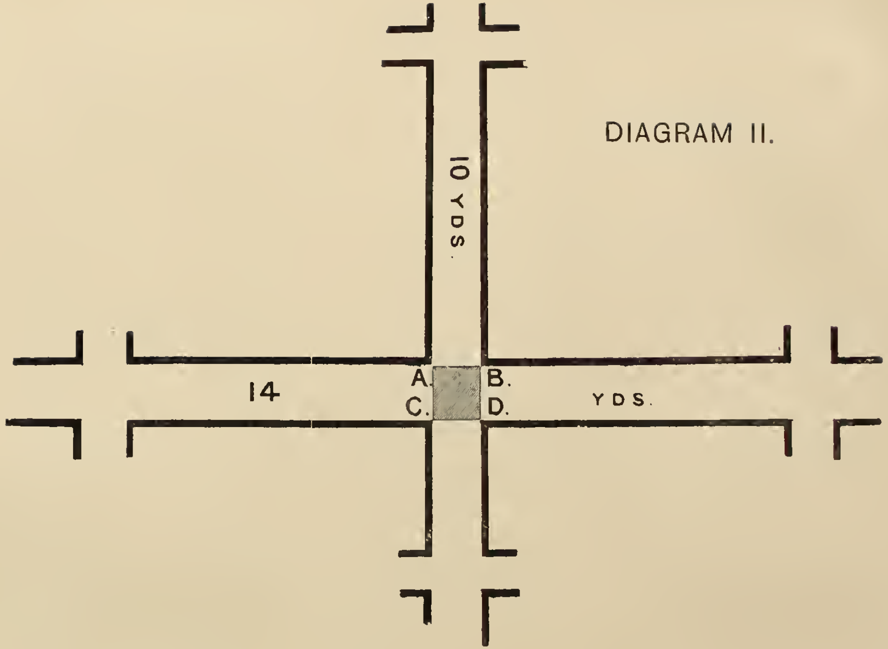

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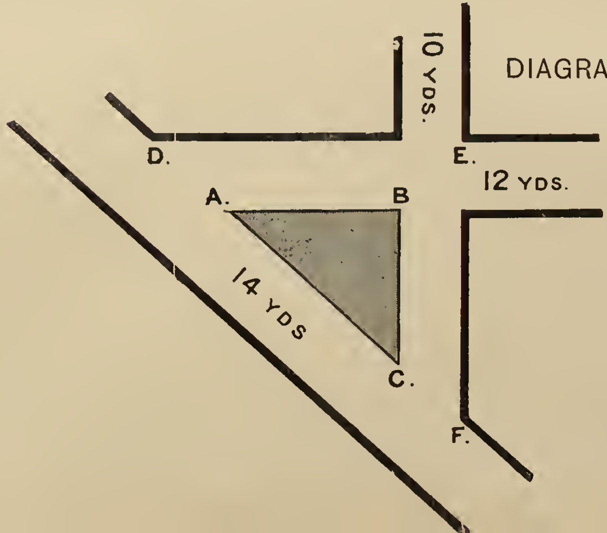

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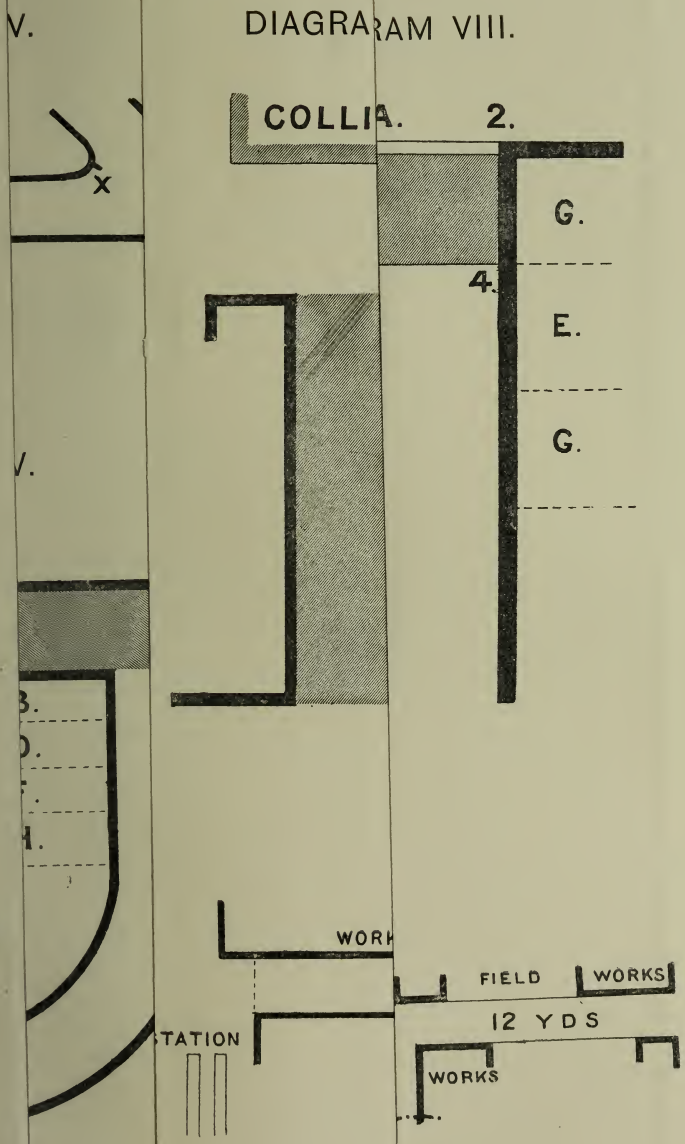
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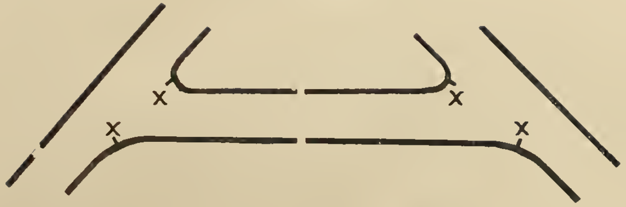
DIAGRAM IV.



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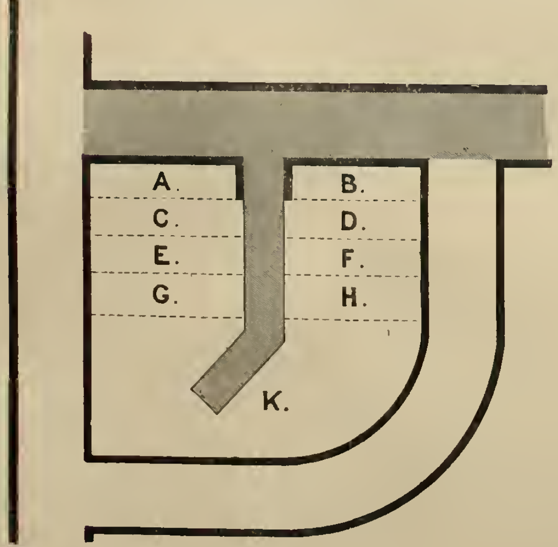
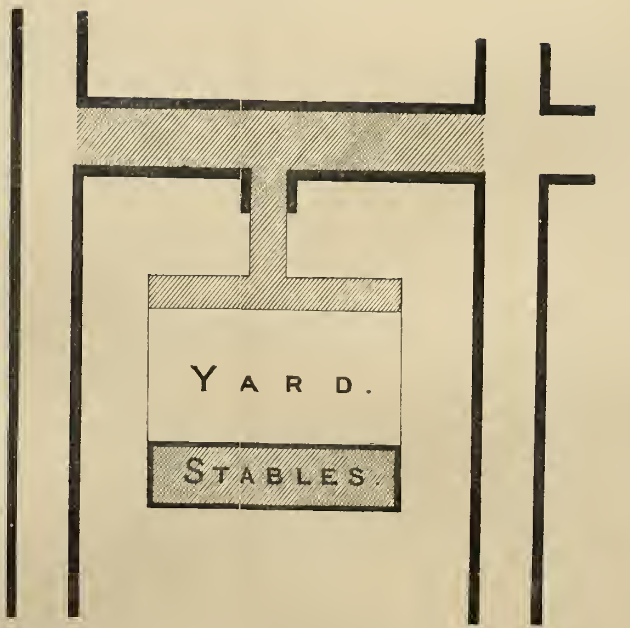


DIAGRAM VI.



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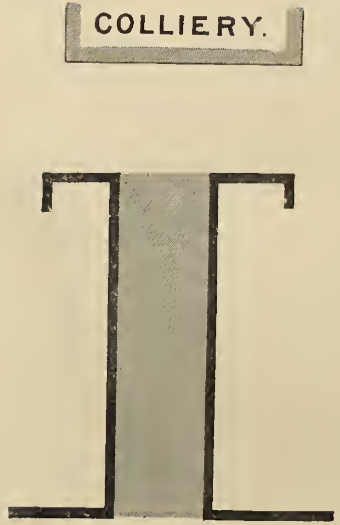


DIAGRAM VIII.

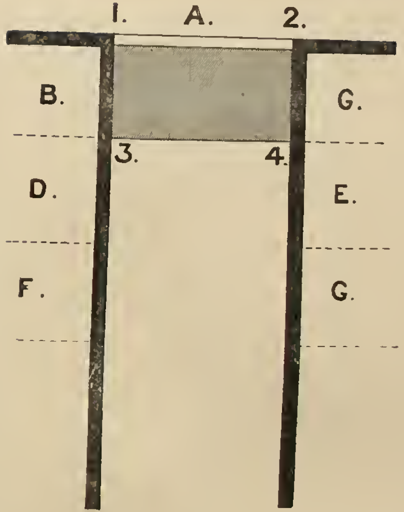
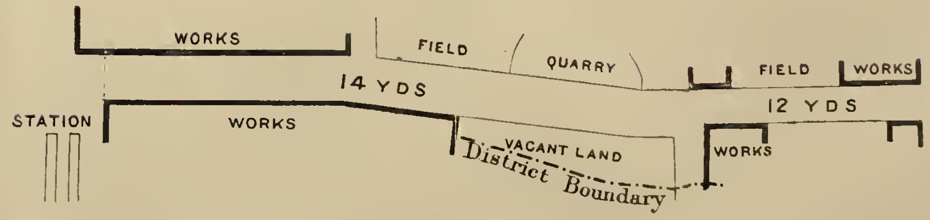


DIAGRAM IX.



To face p. 154.

good effluent, there is no cheaper mode of disposing of the sewage of a town. You are not likely to make a profit, but under favourable conditions you may cover your expenses. I am sorry I have not been able to see the Epidemic Hospital, as I understand it is a very good one. With reference to Mr. Spinks's paper, the subject is one which would take so much time to discuss that I will avoid troubling the members with any remarks about it to-day. I will conclude by moving a vote of thanks to Mr. Brown, at the same time thanking him for the treat I have had on my first visit to Nottingham; and I will also move a vote of thanks to Mr. Spinks.

Mr. C. Jones: I think we can only reiterate what Mr. Eachus has said with reference to these papers. It has been a source of gratification to us to visit a sewage farm carried out so thoroughly and successfully as the Stoke farm. We have seen a good many farms in different parts of the country, but may safely say we have not seen anywhere a more thorough mode of treatment, nor one which showed a more satisfactory result. The effluent of the Stoke farm is one we rarely meet with—we may have seen as good, but not better; and we regard the farm as the most important feature in connection with our visit of yesterday. The other parts of the works in Nottingham, especially the street subways, show the skill of Mr. Brown. There can be no doubt that the construction of subways is the right thing to do; and probably, if we had the laying out of some new town, which had hitherto been undefiled by bricks and mortar, we should not hesitate to adopt that system. There is no question that it is the perfection of town laying-out, as it enables work to be done underground without breaking up the roads. I must also express satisfaction with the other works we have seen, and the complete and thorough way in which they have been executed. I have much pleasure in seconding the vote of thanks.

The vote of thanks having been accorded with acclamation,

Mr. A. Brown, in acknowledgment, said: Will you allow me to say that I am extremely obliged to this meeting for the thanks they have voted to me for this paper. There is one point I wish to emphasise, that is, that no charge is made for running telephone or electric light wires through the subways; the only charge is to the tenants of premises in the street, who are charged a certain rent for the vaults. I thought it would be better to show you a subway which was in course of construction, and where the bricks were being laid; but I could have shown you subways and vaults which have been in use for eight or ten years, but you would have found the vaults crammed with goods and the subways with water and other pipes.

Mr. J. S. **Pickering**: There is one point in Mr. Brown's paper I should like to make a few remarks upon, viz. the admission into the sewers of manufacturing refuse. It seems to me somewhat unreasonable that manufacturers should be able to discharge their refuse into the sewers without some partial treatment. In my district we have great difficulty with this refuse. We have to treat half-a-million gallons a day, and 25 per cent. of that is the refuse from wool-scouring tanneries and other factories. The difficulty we experience is in dealing with this refuse at the sewage works. We may have our treatment set for the ordinary sewage of the day, and may be getting a very fair effluent, and then we may get a run of this factory water and be unable to treat it at all, as it requires entirely different treatment. Then, again, the amount which manufacturers pay to the ordinary district rate is out of all proportion to the advantage they gain in sending so much refuse into the sewers. I know cases where manufacturers pay 80*l.* a year towards the rates, while it costs 150*l.* a year to treat their refuse alone, and also gives a very unsatisfactory result. In Nottingham, where there is a large farm, there may not be so much difficulty, but I have to deal with half-a-million gallons a day on three acres of land, and it is a very difficult problem to solve. Again, new sewerage works may be constructed, and then two or three manufacturers may set up in the town within twelve months, and the whole system may be thrown out of order through the sewers not being designed to deal with the quantity which is sent down. I think something should be done to compel manufacturers to partially treat their refuse before it comes into the sewers. In my case we have given notice to some of the manufacturers to prevent them sending refuse into the sewers without partial treatment.

Mr. W. **Spinks**: This is a question which in Lancashire and Yorkshire is a very important one, and Mr. Brown's paper will be a valuable addition to the engineering side of it. In the Manchester papers of the 5th of April will be found a report of the Mersey and Irwell Watershed Board, at which Sir Henry Roscoe presented a report dealing chemically with five or six different manufacturing effluents which are discharged into those rivers, and showing that it would not be entirely a loss to the manufacturers to deal with those effluents on their own premises. In June last year I had the honour to read a paper before the Society of Medical Officers of Health (North Western Branch) on "Rivers Pollution and House Sanitation," and in the discussion which afterwards took place Dr. Sargent, the Medical Officer of Health to the Lancashire County Council, stated that at a paper works at Darwen the owners were making 2000*l.* a year out of the utilisation of their bye-products, and Mr. Joseph Corbett, Town Councillor of Salford, also cited a case in that borough where 800*l.* a year was realised from a similar source. One of the great difficulties that engineers will have to deal with is this: that when these works were first set up on the river bank it was arranged that the last process in the manufacture should take place quite close to the water's edge, and when manufacturers are compelled to take their trade effluents out of the rivers, it will mean in many cases an entire reversal of the plant. Sir Henry Roscoe's report, however, shows that the difficulties are not insurmountable from a sanitary point of view, and if I may be allowed to say so, Mr. Brown's paper is a valuable contribution to the engineering side of the question.

Mr. McKie: Every one who has had to do with chemical or broad irrigation will admit the importance of this question of manufacturers' refuse. I really do not know what we can do with manufacturers' refuse—whether we shall have to take it into the sewers and do the best we can with it, or whether manufacturers will have to purify their effluent on their own premises. I remember the first time the phosphate of alumina works were started; I was engaged there making experiments for the late Mr. David Forbes, and under his instructions. We had a beautiful effluent at first, but when the gutta-percha or india-rubber works turned down their refuse we had nothing strong enough to battle with the refuse which they occasionally sent down. We got a clear water, but it stank very badly indeed. At the other times we had a very rich sewage, and that no difficulty existed with that was shown in the fact that we had fish and plants living in it. There was in fact no difficulty except when this gutta-percha or india-rubber works' refuse was turned in. If manufacturers would go to the bottom of what they call their waste products, they would find they are not waste products at all, but would, I believe, pay to purify.

Mr. R. Godfrey: I think any members of the Association who propose to read papers in the future should take an example from

Mr. Brown's paper. He had a very large field to cover, and he wisely confined himself to dealing with three points. I cannot criticise his paper; it is past criticism; but I wish to tender my thanks to him for the very great treat he has given us. With regard to Mr. Spinks's paper there is much to be said. He has opened up in his paper a subject which I suppose almost every member of the Association could stand up and talk upon for a week; but I think the more one discusses the paper the more one feels its suggestions lead to further discussion. There are many points in Mr. Spinks's paper to which I take exception. I think myself that we had much better remain as we are under section 150 than open the door, perhaps, to ten thousand more difficulties. Mr. Spinks lays down a point which, I think, goes to the root of the laying of all sewers, and which would lead to much difficultly and expense in the future. He says: "It should be made plain to the surveyor that he must only design sewers sufficient for the necessities of the street he is dealing with." If a surveyor is to do that the whole of his system will be one patchwork of sewers, and he will have to take them up over and over again. It is only right that owners of property should pay for what is required for their own accommodation, and that any further cost should be borne by the rates. With regard to the Act of 1847 and the altering of gas and water-pipes, I have had to deal with that myself, and I contend that if you have to alter the level of a road, the owners of gas and water-pipes, who are simply there by permission, must relay their pipes at their own cost. I had to contend with the Birmingham Corporation on that point, and they have always done it without trouble. To propose to charge the owners of the adjoining property for altering the gas and water-pipes I think would be manifestly unfair. With regard to the Liverpool system of charging the intersections upon the rates, I think it is straining at a gnat and swallowing a camel. Theoretically it may be wrong, but practically it is right. With regard to streets of varying width, I think some improvement might be made in that if the charge was based on the square foot of area. Further, Mr. Spinks opens up a question of apportionment which I do not think it is in the wit of man to deal with. For instance, a piece of land may to-day be worth 100*l.*; to-morrow it may be worth 800*l.* We all know, in dealing with land, that when public authorities want it it goes up to the value of building land in a moment, but if you do not want it for public purposes, but for rating, it is only agricultural land. I do not think myself you can go very far from the lines of the present Act. I admit it is difficult to work, but if you once get away from it you will embark upon a sea of trouble, of which you cannot see the end. I hope, however, when a new Public Health Act comes out that this Association, as the only body of practical professional men in the kingdom, will take care to have its views placed before Parliament. The Council of this Association should take care to be represented, and if the Act can be improved, to have some powers and voice in its improvement.

Mr. J. Lobley: I agree with Mr. Spinks with reference to intersections. It is a very small matter if it is charged to the district rate as Mr. Spinks recommends. But it is not a small matter for those owners of cottage property who happen to have a number of such intersections, and frequently long side frontages as well. Having had ten years' experience of the system in Liverpool, I recommended my Council to adopt it, and I can safely say that the cost has not amounted to 30*l.* a year, with a dozen streets or more each year. It greatly simplifies the apportioning of cost. I am not prepared to follow Mr. Spinks in his proposal that there should be different specifications for different classes of streets. I think the specifications should not be too severe, and if a street becomes an important thoroughfare and requires a different material, that extra cost should be at the cost of the rates. As to the cost of sewers, I agree with Mr. Spinks that "it would be much simpler and more satisfactory if the costs of all sewers were charged direct to the district rates." There, again, the Liverpool system is a most admirable one. The system there is for the authority to make the sewers back and front, and charge a frontage of 6*s.* per yard. That works extremely well. The authority can then put in any size of sewer they please. The subject of adopting a different method of apportionment should be dealt with very cautiously. We all feel that a change in the method should be made, but when we come to suggest a change we face many difficulties. It must be remembered that this Act has been in force forty years, and has become part and parcel of the law of the land, and it can only apply detrimentally to property in streets laid out before 1848. With new streets laid out since then the owner can divide the apportionment of cost on any basis he thinks best, either superficial area, valuation, or any system he likes. For the last ten years I have introduced a system where land is laid out for new streets, for the owners to prepay to the Corporation the cost of laying out the streets without waiting for the 150th section. The owners pay the amount in, a certain discount is allowed, and they are satisfied, and generally the system works well, because the Corporation take over the streets at once. The intersections of streets or corner lots give no difficulty at all under that system, because the owner when he sells the lots distributes the cost over the whole of the property, instead of the frontages. As it is thus so easy to avoid any hardship on new estates, and as older private streets now must become more rare, I think on the whole it would be better to leave the question of frontages where it is, as it has been the law so long.

Mr. A. M. Fowler: I did not intend to say one word on Mr. Spinks's paper, but having heard Mr. Lobley, I think it best to say something. With regard to the method of apportionment laid down in the 150th section of the Public Health Act, 1875, I think there is some ground for improvement. And I will tell you why I think so. You take a street, say, of 150 yards long, under the present system you simply take the length of the frontages and apportion throughout. Take an old street for example—one end may be 14 yards wide and the other end only 4 yards wide. Surely it is not right for a man who lives at the end which is only 4 yards wide to pay the same amount for flagging and paving as the man who lives where it is 14 yards wide. Some of the private Acts in the country are very much better in my opinion than the 150th section of the 1875 Act. Take Leeds for instance. Leeds paved and flagged streets when I was engineer there to the amount of about 27,000*l.* a year. We had no difficulties as to the apportionments; but we had great difficulty as to the notices for old streets. In measuring those streets I always recorded the width of the street as well as the frontage of each property. And so I would go on all through the street. Then you come to the corner of the street, or an intersection of the street, and surely the man who has a corner plot ought to pay more, as that is more valuable than a piece of land in the centre of the block. That is the Leeds system. I say the method of apportionment under the Local Government Act is in my opinion unfair and unjust. It is a very easy way of getting out of a difficulty, this mere rule of three sum, but it is not a scientific way. Then I cannot say I agree with the Liverpool system of making a uniform charge of 6*s.* a yard for the sewer. The principle is good, but it must be remembered that during the last five years the prices of pipes have gone up 50 per cent. I agree that the authority should fix a price, and I have always supported the principle, and was the means in Leeds some years ago of inducing them to get a clause introduced into a Bill, whereby we could charge all the property owners in the same way. With regard to the quality of the paving, you cannot make the quality different for Mr. A. to what you make it for Mr. B. If you make a street and pave it with ordinary setts, that paving wears out and the Corporation have to make it good and keep it in repair. And I contend the most meagre street should be made in a good and substantial way. If the paving is of other than granite setts, the authority should keep it in repair, and it should not come upon the owner. With those slight alterations I think the Local Government Act of 1875 might be improved.

Mr. McKie: I do not believe there is any member of the Association who has given more time to this particular branch of work than Mr. Spinks has, and the words he has used and the recommendations he has made ought to have a little more attention. Some of the suggestions which have been made cannot be carried out with the present powers. Why some of us have to declare a road to be repairable out of rates when it is a macadamised road, quite contrary to the law. If you don't edge, pave, and channel a road you are breaking the law. Whenever there is any new legislation dealing with the question, we ought to consider whether there should not be a first, second, and third-class street, because we all know that what will do for a third-class street will not do for a first-class street.

Mr. Arthur Brown: I should like to make a few observations on Mr. Spinks's paper, as the subject is one of very great importance, especially to the town I represent, where private improvement works are largely carried out.

The author proposes to divide streets into four classes, and suggests that roads "amongst better class residential property, such as suburban roads," should have their surfaces completed with "macadam, asphalte, or gravel"; he suggests, however, that courts, alleys, &c., should be paved with an impervious class of pavement, by which I presume he refers to concrete. If this system is adopted, there would be the anomaly of the best class of property, which can afford to pay the highest rate for street expenses in class 4, being let off with the lightest expenses, and other properties, such as those in class 3, which can least afford it, having to pay for a much more expensive pavement. I agree that the pavement recommended in class 3 is quite suitable, and it is the system I adopt that all courts, yards, alleys, and by-streets, where the houses are back to back, shall have both causeways and carriage-ways paved with concrete.

I object, however, to the owners in streets in class 4 being allowed to put down material (that is macadam) which in the first place is much less expensive, and in the second place costs much more in maintenance, than any other kind of pavement. It may be said that where traffic is light the expense of maintaining macadam is not very heavy, but in some private streets in this town, where the gradients are as steep as 1 in 7 to 1 in 14, it does not require traffic to disturb the surface of the streets, the first thunderstorm does this on such a heavy gradient.

I think that if macadam is accepted for private streets, there should be some special arrangements made, and I suggest the following: (1) that the owners should pay the difference in cost between macadam paving and the paving which would ordinarily be used; (2) that they should pay down a capital sum which would pay for the maintenance of the carriage-way for say twenty years.

If streets are to be divided into classes, I strongly object to this being done by a Local Government Board Inspector; the cry now-a-days is for local self government, all local authorities are trying to narrow down the powers of the central authority, and give to the people in the towns powers to govern themselves; the proper persons to decide the question of what class of pavement should be laid are the officials of the local authorities. There appears to me also to be a very great difficulty in handing this work over to a Local Government Board Inspector, apart from the question of principle. In this town, in what may be considered my short experience, about 400,000*l.* worth of private improvement works have been carried out; in one year 45,000*l.* was spent, and about 120 streets apportioned; it would be a difficult matter for an inspector to be always at one's elbow, to advise in which class a certain street should be put. The author proposes that there should be "an appeal to the magistrates, assisted by a professional assessor, who should decide under which class the particular street should come," and says "that the great object is to come to a satisfactory understanding with the owners before the works are commenced." I am afraid if these two formalities have to be gone through, and especially the latter, that the progress of private street works in large towns would not be very rapid.

I regret that the author has apparently thrown some amount of discredit upon his brethren by saying that the execution of works by their own staff is "open to grave abuses, entails more labour on the surveyor and his staff, and nearly always gives dissatisfaction." As regards the first charge, I am quite unable to see where the grave abuses come in any more than they should do if let by contract. I have executed three-fourths of the private street works in this town by our own staff, buying all stone by contract and letting all the work piece work, and have never regretted having adopted the system; it is true it is more labour to the surveyor, but that does not count for anything.

The author suggests that the cost of all sewers should be charged direct to the district rates, and compares the putting in of sewers to water-pipes, which he says are charged to a common fund. I do not think the comparison is a good one; the putting in of water-pipes is part of the work of a trading concern, who get a revenue from their capital outlay; and this is not the case in sewerage works. Further, this would be a very heavy burden to cast on the rates in some towns where private street works are done at the rate they have been in this town. In some years the sewers apportioned would cost from 12,000*l.* to 15,000*l.* a year, equal to a 4*d.* or 5*d.* rate. He would be a very courageous man who would dare to suggest that this system should be adopted in this town.

The suggestion that the excess in cost of a main trunk sewer in a certain street over the cost of a sewer sufficient for the requirements of the street should be borne by the local authority is a good one, and should be acted upon.

As regards the apportionments being made according to the rateable value instead of according to frontage, I fail to see that this would be any advantage or would be any fairer. It is conceded that the present system of apportioning according to frontage operates harshly in some cases, but cannot this be said of many laws? and my opinion is that the apportionment according to rateable value would cause much more dissatisfaction than apportionment by frontage.

I should like to enlarge upon this and give instances, but I have taken up so much space that I am disinclined to intrude further upon your time. I may say, however, in conclusion, that after my experience upon this work for eighteen years, and having carried out private street works at a speed, I believe, unequalled in any other town, I fail to see that any very great improvements could be made in the Public Health Act on this point,—most of the suggestions made by the author are not, in my opinion, improvements.

As regards the Bill to amend the Public Health Acts in relation to private street improvement expenses, which has been prepared on behalf of the Association of Municipal Corporations, I am most strongly of opinion that if the authors of that measure wished to devise means of making the carrying out of private street improvement works so difficult that the result would be to put a stop to all such works being undertaken and carried out by corporations, nothing could have been devised more certain to effect this purpose than the Bill in question if it became law. I think that this Association should strongly object to this Bill, and their opinion, as being that of men more thoroughly acquainted with these works, should be made known on this question.

On Friday, the 29*th, after the reading of Mr. Brown's paper, the meeting adjourned to enable the members to visit the subways in course of construction, and which are described in Mr. Brown's paper. The construction of the subways, and the admirable arrangements made to receive the "wondrous underground organism" of a large town, excited much interest. After a tour of the subways now being built, the members were received in one of the passages which had been specially prepared for their reception. A sumptuous luncheon was provided by Mr. A. Brown and Mr. J. Parker, whose hospitality was much enjoyed by the company, and to whom very cordial votes of thanks were accorded.*

After luncheon a test was made of Hassall's patent safety joint for earthenware pipes. A length of pipe fitted with the joint was tested up to a pressure of 100 *lbs. to the square inch, when the pipe gave indication of fracture, but the joint remained intact.*

On the conclusion of the reading of the papers the members proceeded in brakes to the Corporation Sewage Farm at Stoke, about four miles from Nottingham. Mr. Aviss, the manager of the farm, met the members on their arrival at Stoke, and with Mr. Brown, explained its scope and mode of working. The farm under cultivation at the time of the visit of the Association consisted of about 700 *acres, but an additional* 270 *acres had been recently purchased, and will be shortly brought into cultivation. A large number of stock are fed on the farm, and large quantities* *of milk sent to the London market; while crops of wheat, rye grass, mangolds, &c., are raised on the farm. About* 130 *acres of the farm are drained with* 12*-inch main drains two chains apart, and* 4*-inch drains ten yards apart, and the remainder has main drains* 4 *chains apart, and* 4*-inch drains* 20 *yards apart. Between six and seven million gallons of sewage are dealt with daily on the farm, flowing by gravitation from Nottingham in a period of about three hours, and the effluent leaving the farm is eminently clear. The condition of the farm, and the arrangements made for receiving and dealing with the daily flow of sewage were regarded as most satisfactory, and called forth the highest expressions of praise and congratulation to Mr. Brown and the manager.*

DISTRICT MEETING AT NOTTINGHAM.

April 30th, 1892.

Held in the County Hall, Nottingham.

Lord Belper, Chairman of the Nottingham County Council, having taken the chair, opened the proceedings of the County Meeting with an address. His Lordship, who was received with applause, said: Gentlemen—In taking the chair, perhaps I ought to say a few words to express for myself the great pleasure I have in being able to accept the honour which you have conferred upon me. I am very happy on behalf of the county to welcome so important a body as the Members of the Association of Municipal and County Engineers, and I can only hope that, so far as the county is concerned, your visit may be a success. I am very glad to be here today because I take considerable interest in the subject you are about to discuss, and also because I am very sensible of the debt which is owing by the public generally, and especially the public bodies of the country, to the members of your profession. The extreme ability, and the sound and business-like training which your profession gives to all within its ranks, enables those authorities to have the work which they have to do done in a most satisfactory manner. I am sure I may express, on behalf of the county of Nottingham, my acknowledgment that the county, no doubt in common with other counties, has a most able representative of your body to conduct the engineering affairs of this county in Mr. Hooley. I am afraid we cannot show in the county, like some of the large boroughs can, those imperishable monuments of engineering skill; but at all events you have the satisfaction of knowing, you who are good road makers, that there are thousands of the public who bless you, and that you are adding very much to the good humour and contentment of the country. I do not want to discuss questions which you are very much more capable of discussing than I am, and it would be extremely foolish for me even to suggest the lines on which you should carry on your business; but I should like to say this: that I think you as surveyors, county surveyors, and surveyors representing the different public bodies of the country, have at all events a right to feel that your position and your work should not be hampered by needless regulations made by Parliament or by Government. I am well aware, and I think you are all aware, from the experience of the last three years, that there are points in the law with respect to the management of main roads which we should like to see altered. I do not wish to refer to them at any great length, but I think I may specially refer to the arrangements which the counties have to make with local bodies. I need mention only one or two points very shortly. The county have to lay down a standard of what is a satisfactory state of the roads. The county surveyor cannot give a certificate unless he considers it so. What the standard of the road is to be can only be made by the surveyor pointing out to the local authority, if necessary, in clear terms and specifications, what he considers the most desirable way in which the road shall be managed. But it is extremely doubtful under the existing law whether that is practicable. Again, it is extremely desirable in the interests of local authorities that payments should, if it is desired, be made not only at one time, at the end of the year, long after the expenditure has been incurred, but should be made from time to time as may be most convenient to the local authorities. But it is more than doubtful whether such payments could be made; and if some dispute arose, whether it would not prejudice the position of the county. Then it seems very desirable in certain cases that the roads should be inspected and that certificates should be granted at different times, and that if necessary a part of the grant might be given, even though the road might not be in good repair all the year round. No doubt many of these things could be done by arrangement between the authorities, but I think the law should be so altered that there should be nothing to stand in the way of the most satisfactory management for the efficiency of the roads between the local authorities and the County Council, and I hope when any change takes place that greater latitude may be given to the County Council and the local authorities to arrange between themselves what they consider the most efficient manner to manage the main roads. I hope in the discussion you are going to have, and so far as any of us have any influence in the country, we shall try to approach this question in a conciliatory spirit, that is to say, that we shall simply keep one thing in view, "what is the most efficient way of managing main roads?" I only say this because local bodies and representatives of local bodies when they come together on financial business are apt to look at each other with some suspicion, and the feeling is that "the other side are going to do me." I venture to think the real matter which you as engineers will direct your attention to is the efficient management of the main roads, and if we approach each other in a conciliatory, and what I may call a proper spirit, it is much more likely that that will be satisfactorily effected than by any jealous suspicion. I shall now vacate the chair in favour of your President, but propose to remain to hear the paper which is about to be read, and the discussion which will ensue upon it.

The President, having taken the chair, said: Before we commence the discussion I will just say we all take it as a great compliment that his lordship has come here this morning to address these remarks to us, and we thank him for his attendance and address. The topic he has struck upon is one of great interest. It is a question which is engaging the attention of both county and local surveyors throughout the whole of this country, with perhaps the one exception of the County of Nottingham. I believe this county stands alone in the fact that they have no dispute at all with the local authorities. They seem to have hit upon the spirit and intention of the Act, and to have carried it out in such a manner that the Nottingham County Council may be looked upon as the model county council. Unfortunately it is not so in other counties, but I hope that the remarks of Lord Belper on this question will not be lost sight of, and that county authorites will try to emulate the good example of Nottingham, and that these differences, of which we have heard so much, will cease.

I hope county and local authorities will endeavour to pull together for the interest of the ratepayers and those who use the roads, and that we may hear no more of these disputes. I trust that the county authorities will meet the local authorities in a generous spirit, and that the local authorities will keep the main roads in as good repair, and with as much economy as possible, for of course the local authorities must not be extravagant.

COUNTY MANAGEMENT OF MAIN ROADS.

By JAMES ROBINSON, County Surveyor, Hants.

Having been invited to contribute a paper to be read at this meeting of the Association, the writer consented to do so, although fully convinced that an abler contributor might well have been found. The remarks he has to make will, he trusts, at least furnish a subject for discussion and exchange of views, especially in relation to main roads in urban districts, and thus enable the urban and county members of the Association to become more in touch with each other, and appreciate better the various difficulties which arise in advising their respective authorities. He must also beg it to be understood that he speaks for himself alone, based on his own experience, and does not claim to be the mouthpiece of county surveyors generally, the management varying too much for him to do so, even if disposed.

The subject matter of the paper is confined to "Main Road Management," and does not deal with the methods of maintenance. To fully appreciate the present position of affairs, it will perhaps be useful to refer back to the time when main roads were first established in 1878. This was done by the Highways and Locomotives Amendment Act of that year.

All roads which had been disturnpiked between December 31st, 1870, and August 1878, or were subsequently disturnpiked, became main roads (sect. 13), and power was given to declare other roads main roads (sect. 15); the county authority had to pay the local authority (rural or urban), one-half the cost of maintenance (ascertained by audit), on the county surveyor certifying that the roads had been properly maintained; the local authorities could be called upon to keep such accounts as the county authority required.

Having been County Surveyor for Hants for some time prior to the date referred to, the responsibility of working the Act devolved upon the writer under the chairmanship of the Right Hon. G. Sclater-Booth (now Lord Basing), who, as President of the Local Government Board, had been responsible for the passing of the

Act. Fortunately, Hampshire had, wisely, been divided into highway districts in 1863, under the Highways Act of 1862, thanks to the forethought of the Quarter Sessions, and thus there were duly constituted Boards and officials of some experience to deal with, instead of, as in so many cases, a multitude of parishes with those officials misnamed surveyors. The authorities were required to submit their claims for maintenance on forms (following, for convenience of audit, &c., the lines of the highway forms prescribed by the Local Government Board), issued by the county authority and audited by the Local Government Board Auditor; these were examined by the writer and reported upon; the roads were inspected twice a year and certificates given, upon which the local authorities received the moiety of the expenditure they were entitled to; happily no friction arose, matters worked smoothly, a more general system of maintenance resulted, and the roads improved.

Rightly or wrongly the county authority declined to recognise footpaths by the sides of the roads and the local authorities acquiesced therein. The Act was a useful Act, and was no doubt the first step towards the later Act throwing the whole charge of the main roads upon the county.

The accounts having all passed through the writer's hands, he is able to give some figures in the Schedules at the end of this paper, and which he trusts may be of some interest and use. It will be seen the expenditure has been anything but extravagant, but being an agricultural county the traffic generally is not heavy, and Hampshire is favoured with local material of fair and suitable character. Moreover, some of the roads or portions of roads, although dignified by the term "main," are not "principal" roads, but being old turnpike or branches of same, whose days of importance have passed away, have now very little traffic on them.

One result of the careful and economical management of the roads cannot perhaps be considered altogether satisfactory, inasmuch as the amount of the grant now received from taxes (the Probate Duty Grant) in aid of county expenses, was calculated upon past expenditure, consequently those who spent least got least, and those who spent most got most, being rather a premium on extravagance.

By the Local Government Act of 1888, county authorities, who previously were only contributing authorities, were charged with entire responsibility of the maintenance of the main roads, both existing ones or any other roads which might be raised to that status.

A reference to the bill as first introduced into the House of Commons shows that it was intended that this maintenance as regards rural roads should be undertaken direct and without any option of delegating the duty to any other authority, and the proposals with regard to urban authorities claiming to retain and the payments to be made were more limited, and the writer cannot but think it would have been infinitely more satisfactory had those intentions been adhered to. As it is, power is given to county authorities to require local authorities to maintain the roads under certain conditions as to payments and so forth (sect. 11, sub-sect. 4); urban authorities are entitled to "claim to retain the powers and duties of maintaining and repairing" (sect. 11, sub-sect. 2), being paid "an annual payment towards the costs of the maintenance and repairs and reasonable improvement connected with the maintenance and repair of such roads."

In Hampshire the whole of the urban authorities (twelve) claimed "to retain," and these will be dealt with presently. In the case of the remainder of the roads (in twenty-two rural districts) the County Council, after due consideration, decided not to maintain the roads themselves direct, but to avail themselves of the power of requiring the local authorities to undertake the work for them. Personally the writer regrets this much, and he feels sure all those professional men charged with the duty of road maintenance and supervision, will agree with him in the opinion that direct management by the responsible authority is the most satisfactory.

In carrying out this decision, in order to obviate as far as possible the difficulties attending the arranging of hard and fast "lump sum" contracts, it was settled that the local authorities should first submit an estimate of the cost of their respective roads for the ensuing year; after these have been examined and agreed upon, contracts are entered into, and the work of maintenance proceeded with under a general specification, provision being made for interim payments; an audited statement of the expenditure is submitted at the end of the year, and the actual expenditure repaid, provided it does not exceed the amount of the estimate; where it does, the excess is paid only on the writer certifying that it is a proper expenditure. An agreed sum is also paid in respect of establishment charges.

Having had the previous accounts continually through his hands, and being intimately acquainted with the roads, it has been possible to work this system fairly well, and the actual expenditure only having to be paid has removed anxiety as to possible losses from the minds of the local authorities and the fear from the county authorities that the full amount had not been expended, but of course it is impossible to get a really uniform and entirely satisfactory system of management where twenty-two authorities have to be dealt with, with twenty-two surveyors of varying capacity and experience to interpret and carry out instructions.

The expenditure for the three years of County Council management is given in the Schedule. The account forms are now arranged so as to show clearly the exact expenditure under the various heads, which was not entirely the case in the old form. Hitherto paths have not been maintained by the county, but it is now proposed to do so.

Now with regard to urban authorities, it has been mentioned they have all claimed to retain, and therefore it is necessary to agree with them as to the amount to be contributed by the county "towards the costs of the maintenance and repairs, and reasonable improvement connected with the maintenance and repair" of the respective roads. Claims in detail are submitted and examined in the light of the previous expenditure, as shown in the accounts before mentioned; offers are then made of such sums that are considered would be sufficient to keep the roads in sound repair, irrespective of such watering, cleansing, &c., beyond that really necessary for maintenance.

Agreements have been come to from time to time with all the authorities, except one, and the difference in that case between the two authorities was so great that resort was necessary to the arbitration of the Local Government Board. One enquiry has been held, and it is almost inevitable that a further one must be held with respect to subsequent years.

The sums agreed upon are paid in two instalments on the certificate of the writer that the roads have been properly maintained.

It seems to the writer that this unfortunate sub-sect. 2 of sect. 11 is a most unsatisfactory one; under it, when an urban authority claims to "retain," the county authority practically loses all control of the roads, yet has to pay for their maintenance; the urban authority, failing agreement, can, if it chooses, run up the expenditure on them, whether quite necessary or not, without consulting the county authority, call upon the county authority to pay for that expenditure, and on the latter refusing, resort must be had to arbitration, held, probably, long after the expenditure has been incurred, causing long delay in settlement, with a result unsatisfactory to one, or more likely to both parties. Then there is that apparently simple word "towards," which is held by some to mean "all" and others "part" only of the expenditure. It was hoped that the awards of the Local Government Board would have thrown more light on its meaning, but as yet they have not done so. The well-known Warminster case has tended also to increase the dissatisfaction felt by county authorities with regard to the clause, inasmuch as the difficulties attending settlement in respect to the repairs of carriage ways are not lessened when applied to footways of whatever character, crossings, &c.

There are urban authorities, and the writer is glad to testify to it, with whom it is not difficult to come to agreement, but when these find others increasing their demands and see the result, naturally, and it may be said almost in self-defence, they are driven to a different course.

There are other difficulties arising out of the section in which there may be legitimate difference of opinion not easy to settle and adding to the difficulties of surveyors in advising their respective authorities; such as the extent of cleansing necessary for maintenance, the extent of watering necessary for the same purpose, the provision to be made for snow clearing, the substitution of one material for another for footways, and such like.

The writer is of opinion that inasmuch as the county authority have to provide the funds for the maintenance of the roads they should have the first voice in the expenditure of those funds, and that can only be secured by the repeal of sub-sect. 2 of sect. 11. The roads could then be maintained either direct by the county authority (sub-sect. 1) or by agreement under sub-sect. 4. In the former event, power, if thought fit, could be given to the urban authority to appeal to the Local Government Board if they considered the roads were not being kept in a satisfactory condition.

In the attached Schedule I have given some figures relating to the rating that would have been required to meet the road expenditure, from which it will be seen that the balance is in favour of the urban authorities.

COUNTY

SCHEDULE OF COST OF MAINTENANCE OF

Period.	Total Cost.		Mileage, and Average Cost per Mile.											
			All Roads.				In Rural Districts only.				In Urban Districts only.			
			Mileage.	Average Cost per Mile.			Mileage.	Average Cost per Mile.			Mileage.	Average Cost per Mile.		
Year ended		£		£	s.	d.		£	s.	d.		£	s.	d.
March 25, 1880		8,972	382·17	23	9	6	394·28	18	10	4	27·71	86	0	0
Do. 1881		10,277*	476·26	21	11	7	443·83	17	12	10	29·71	78	6	4
Do. 1882		11,386	493·75	23	1	3	452·53	18	12	1	34·30	80	4	6
Do. 1883		11,684	504·97	23	2	9	469·12	19	2	4	35·85	75	15	3
Do. 1884		11,643	504·97	23	1	1	469·12	18	14	6	35·85	79	14	11
Do. 1885		11,483	523 12	21	19	0	486·29	17	7	11	36·82	82	1	10
Do. 1886		12,050	531·75	22	13	2	492·30	17	0	2	39·45	93	3	0
Do. 1887		12,958	531·75	24	7	4	490·91	19	9	10	40·84	83	2	0
Do. 1888		15,209	531·75	28	12	0	490·91	22	6	8	40·84	103	19	2
Do. 1889		14,356	531·75	27	0	0	490·91	20	2	8	40·84	109	9	9
March 31, 1890	Rurals	9,597*	556·70	28	18	8	498·22	19	5	1	58·48	111	6	9
	Urbans	6,511§												
	Total	16,108												
Do. 1891	Rurals	9,954*†	556·70	31	12	3	498·22	19	19	10	58·48	130	14	10
	Urbans, say	7,647§												
	Total	17,600												
Do. 1892	Rurals	11,516*†	556·70	34	10	5	498·22	23	2	3	58·48	131	14	0
	Urbans	7,702§												
	Total	19,218												

MEMO.—In addition to the main roads there are about 3100 miles of rural district roads, the County Boroughs of Portsmouth and Southampton), with an expenditure of about

OF HANTS.

MAIN ROADS FROM MARCH 26TH, 1879.

Cost per Mile of Individual Roads.												Remarks.
In Rural Districts.						In Urban Districts.						
Minimum.			Maximum.			Minimum.			Maximum.			
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	
1	3	0	134	0	0	16	0	0	188	0	0	
0	11	4	127	12	7	22	4	2	182	5	0	* Snow clearing cost 548*l.* in addition.
1	12	0	139	11	9	12	6	8	166	19	0	
1	12	5	209	7	6	8	6	8	209	0	0	
1	3	9	207	1	0	7	5	0	324	2	3	
1	1	0	172	2	2	19	15	4	548	3	5†	† For a short piece of road only.
1	7	3	138	11	10	3	0	0	358	5	6	
0	17	3	190	4	2	4	14	1	332	10	1	
1	0	0	197	14	4	12	10	0	309	17	4	
1	1	7	239	10	11	22	0	0	465	13	4	
												* 902*l.* per annum also paid annually in respect of establishment charges. † Snow clearing cost 438*l.* in addition. § These urban totals are contributions "towards" only, and are exclusive of paths and establishment charges. The contributions to the latter were 1890–1. 1891-2. Paths, say .. £1304 £845 E.C.'s, say .. 391 386

with an expenditure of about 20,000*l.* and about 210 miles of urban district roads (exclusive of 13,500*l.*

COUNTY

SCHEDULE OF COST OF MAINTENANCE

Period.	Mileage.	Quantity of Material.	Expenditure.		
			Manual Labour.		Team Labour.
			Spreading.	Siding, Scraping, &c.	
RURAL DISTRICTS					
		cub. yds.	£ s. d.	£ s. d.	£ s. d.
Average for the 6 years ended March 25, 1889	486·74	41,155	716 6 5	1,706 18 0	2,975 18 5
Average per mile ..	..	85	1 9 5	3 10 3	6 2 6
URBAN DISTRICTS					
Average for the 6 years ended March 25, 1889	39·10	10,000	210 0 0	390 0 0	800 0 0
Average per mile ..	..	256	5 7 7	10 0 0	20 10 3
RURAL DISTRICTS					
Average for the 3 years ended March 31, 1892	498·22	40,118	539 17 10	2,106 9 3	156 11 9
Average per mile ..	..	80½	1 1 8	4 4 6	0 6 3
URBAN DISTRICTS					
Average for the 3 years ended March 31, 1892	58·48	..	..	..	..
Average per mile ..	..	..	..	..	..

EQUIVALENT

	Rateable Value.	Average Cost for 3 years 1889-90 to 1891-2 exclusive of establishment charges and paths.
	£	£
Rural districts	1,220,527	10,356
Urban ,, ...	653,451	7,286
Total	£1,873,978	£17,642

OF HANTS.

OF MAIN ROADS. AVERAGES, &c.

Expenditure.			Remarks.
Materials.	Tradesmen's Bills and Miscellaneous.	Total.	
1883–4 to 1888–9.			
£ s. d.	£ s. d.	£ s. d.	
3,683 2 9	257 18 3	9,340 4 0	MEMO.—For the first 6 years, the quantity of material is that which was brought into account, and the team labour is mostly for haulage of materials (according to the Local Government Board's prescribed form of account). In the last 3 years, the quantity of material is that actually spread and used, and the team labour is exclusive of any haulage of material. The material is mostly flint and gravel, some imported hard stone being used in some of the urban districts.
7 11 6	0 10 8	19 3 9	
1883–4 to 1888–9.			
2,010 0 0	200 0 0	3,610 0 0	
51 10 9	5 2 6	92 11 3	
1889–90 to 1891–2.			
7,072 11 2	480 10 9	10,356 1 2	
14 3 11	0 19 3	20 15 8	
1889–90 to 1891–2.			
..	..	7,286 0 0	
..	..	124 11 9	

RATING.

Rate in the £ required.	Remarks.
£ 2·036 pence	If the cost had to be raised by rate, the Rural Districts would contribute 11,449*l.*, or 1093*l.* more than is spent in them; and the Urban Districts 6193*l.*, or 1093*l.* less.
2·676 „	
2·205 „	

DISCUSSION.

The PRESIDENT said: My lord and gentlemen, there is something to be said in favour of some of Mr. Robinson's arguments and, I think, something to be said against others. However, I do not propose to-day to express an opinion on this paper, although there are some points which are eminently worthy of discussion. I know there are surveyors present who are particularly interested in the question of payment of the cost of the maintenance and repair of main roads, and they will perhaps give us their views.

Mr. CHARLES JONES: I have much pleasure, Mr. President, in proposing a vote of thanks to Mr. Robinson for his paper, and I am quite sure that there will be but one opinion in this meeting as to the value of it, however much we may differ from some of the statements made. I know there are some gentlemen in the room who are more at home with the general question than I can claim to be, but I will say that, admitting Mr Robinson's experience to be large, and devoted particularly to county work, I cannot but think he is wrong in some of the statements he has made, or at any rate, that they are open to a certain amount of question. I would particularly refer to the repayment, or payment by the county, for the paving of roads, which seems to be one of the vexed questions at the present moment. I cannot but think that it is far better, and quite equitable, that County Councils should deal with this question in the same spirit as I understand it is being dealt with in the county of Nottingham. This is the one great difficulty which seems to be annexing itself to all the statements of accounts which are sent in. I cannot see why exception should be taken by a county that when it takes to a road that road shall extend only from curb to curb. Surely the footpath is as much part and parcel of the road as that portion which lies between the curbs. Why should not the County Council take the entire responsibility for dealing with that part of the road? I know there have been views expressed as to the probability that the interesting village of so-and-so will feel that it is a matter laid on its conscience to pave its paths with York paving or something more expensive, if they can find it. That is one of the arguments used to combat the contention as to the liability of the County Council in regard to footpaths; but that seems to me to be only a species of "mare's nest." If there is to be any difficulty of that kind the power of reference to the Local Government Board will put an end to it once and for ever. The Local Government Board will soon decide, and the question be settled in a manner which will commend itself to the intelligence and common sense of the surveyor who has charge of that particular district. It is somewhat of a slur on county surveyors, some of whom I have the pleasure of knowing, to suppose that they would veto the construction in a proper manner of the footpaths in their respective districts. There are some of us here to whom paving is a matter of very great expense, and to whom road-making is also a matter of great expense. Take my own district for instance, where my main road involves me in an annual expense of 1100*l.* or 1200*l.* per mile. Of course there is no comparison to be drawn from these figures; but I find no difficulty whatever with the county authorities. I have never had a dispute with the respected surveyor of the county of Middlesex in regard to any of my accounts, nor do I think there should be any such dispute in any county. I quite think with Lord Belper as to the advantage of meetings between the different authorities having charge of roads, and think that such conferences would lead to difficulties being discussed in a friendly and kindly manner, and so amicably arranged that in the end the right and proper thing for our respective districts will be done. It appears to me that if that condition of things which Lord Belper foreshadowed is brought about, the day will come when the need for referring these disputes to arbitration will have passed away, and we shall not have to trouble our President to travel north and south to give evidence in these cases. I have not made a claim hitherto for the paving of my footpaths, but shall be compelled to do so before many months are over. When the question arises I have no doubt that it will prove an expensive one, for some of my footpaths are almost as wide as my roads, but I have no hesitation in asserting that the County Council, with which I am associated, will agree to a fair and equitable arrangement in respect of paving. With regard to watering and cleansing I can hardly go so far as to say that watering and cleansing are not necessary to road maintenance, but hold that to a very great extent they are necessary; but I think it would be unwise to raise the question, as we should have no end of arbitrations and disputes, for Mr. So-and-so would think that so many thousand gallons of water should be used within such and such a period, while I or somebody else might think twice as much was necessary. I think, however, that the point should be settled in our own minds that cleansing and watering is necessary for the maintenance of the roads in every district.

Mr. F. SMYTHE: I am unfortunately in the position of representing one of those authorities which cannot get on very well with the County Council, or rather, as Mr. Jones very happily puts it, cannot get on, not so much with the County Council as with their surveyor. I quite agree with Mr. Jones that the establishment of a mutual understanding between the two surveyors would serve to rub off a great deal of the difficulty. I have no hesitation in saying that so far as the footpaths are concerned, those who claim for them will in the end get them, because of course the Warminster case clearly defines that portion of the Act. I am not going to make any comment upon Mr. Robinson's paper, which is a very valuable one. There is only one point to which I wish to allude, viz. in all the papers and statistics I have seen bearing on this question, and even in the recent edition of Mr. Codrington's book, the average cost per mile is given and the length of road; but nothing is said of what I regard as the most crucial point. You see that such and such a road costs so much per mile; but you have not seen the road, and you do not know what sort of a road it is, or what sort of traffic there is over it. I think that, if it is possible to obtain the information, we should have a column added to these schedules giving, in addition to the cost of the road, statistics as to the amount of traffic over them. Without such statistics it is impossible to arrive at an adequate idea as to the wear and tear of a road, and, consequently, at what the renewal of its surface should cost. I should very much like, if it were possible, for Mr. Robinson to add such a column as I refer to in his paper, giving information, I do not say as to all the roads, but as to one or two, stating the number of vehicles that use them, the character of the traffic, and the kind of stone used. That is one of the principal points I should like to see in papers of this description.

Mr. E. P. HOOLEY: I think it is known pretty much by the members of the Association that I have the credit of taking an advanced view of the new County Councils Act. But it should be remembered that in these matters I do not give expression to my own thoughts, but to those of my council, who have, I am pleased to say, a very advanced and proper idea of the manner in which the Act should be administered. The Council, of which Lord Belper is the chairman, is as clear-headed and as business-like as any County Council in England. For my own part, I have always said, and I always shall say, that we have the best council in England, for they look at things in a reasonable light, and do not squabble over the word "towards," or raise questions as to whether people who live in country places always use the roads and never use the footpaths. The fact is that footpaths are just as much part of the road as the road itself, and should be kept up just as efficiently. No one would be so ridiculous as to suggest granolithic pavement for the footpaths of a village consisting of a couple of small shops and a public house; but in town districts it is necessary that there should be good footpaths, not only for the people who live in those districts, but for the country people as well; and if the local authorities have retained the management of the main roads the County Council of Nottinghamshire, at any rate, think it unfair to require them to bear the whole expense of maintaining the footpaths, or to say that they shall pay through the nose for it. They say, "what it is necessary to spend on repairs in reason"—and the word reason is construed intelligently—"we will repay you," and they do repay the local authorities the amount expended without quibbling or quarrelling as to the precise terms of the Act and the manner of interpreting this word or that. Looking through the paper we have just heard read, I must say there are two or three points on which I disagree with Mr. Robinson, although on others I can endorse his opinions. He says in the early part of the paper, "Fortunately, Hampshire had, wisely, been divided into highway districts in 1863, under the Highways Act of 1862." Unfortunately, in the county of Nottingham, in the olden time, we were not divided into highway districts. We had a succession of parishes which managed—or mismanaged—their own affairs. Since I have been here I have been told by the surveyor of a large parish that when he had the management of the main roads in his own parish he never made a district rate for two years, but appropriated the money he got from the county on improving the district roads, without spending a penny more than he could help on main roads. You can imagine the result of such a state of things, and that at first it was no very easy thing for the County Council to discharge its duty. He (Mr. Robinson) says, "Rightly or wrongly, the county authority declined to recognise footpaths." I think if he had said "wrongly" he would have been right, because, as I said, footpaths are part of the roads and should be treated as such. Mr. Robinson says, "One result of the careful and economical management of the roads cannot perhaps be considered altogether satisfactory, inasmuch as the amount of the grant now received from taxes (the Probate Duty Grant) in aid of county expenses was calculated upon past expenditure, consequently those who spent least got least, and those who spent most got most, being rather a premium on extravagance." Perhaps Hampshire is differently situated to our county, but I never knew that those who spent least got least from the country. Possibly it is correct, but I never heard of it before. I do believe this, that if you go on a system of averages anywhere you will get a very bad result. There is not a man in this room who will say that he can take the cost of maintaining his roads for the past seven years, and that the cost during the next seven years will average exactly the same. It is impossible. If a man goes by averages he either gets too much or too little for his roads, and we generally find that it is too little, the result being that the roads get starved, and that the county authorities in the end have to pay through the nose for the necessary repairs and maintenance. Mr. Robinson goes on to say that in the case of twenty-two rural districts he regretted to say "the County Council, after due consideration, decided not to maintain the roads themselves direct, but to avail themselves of the power of requiring the local authorities to undertake the work for them." I agree with Mr. Robinson in that rural main roads should be managed by the County Council direct, and there should be no power of delegating the duty to any other body. If the rural authority does the work, you may depend upon it that it will be with the idea of making a profit; and I say, without hesitation, that if a County Council is not strong enough to manage its own affairs, the sooner it loses its authority the better. Lord Belper, who is a much better lawyer than most lawyers, for the reason that he deals with all matters that come before him from an intelligent common sense point of view, at the last meeting of the Nottingham County Council actually besought the members to try their utmost to meet the views of the urban authorities, and instead of making the payments under the Act annual payments, to make payments on account so as to relieve the district rates as much as possible. In the next paragraph Mr. Robinson says, "Personally I regret this very much, and I feel sure all those professional men charged with the duty of road maintenance and supervision, will agree with me in the opinion that direct management by the responsible authority is the most satisfactory." I know a little about Hampshire, as I sometimes go on a visit to a little town there. I am very often highly amused when I see two systems of road-making going on in the same district. On one side you may see a splendid system, and on the other a system of a very questionable kind. In one district the road surveyor is also the tax-gatherer, in another there is an individual who combines the occupations of auctioneer and road surveyor, in another we have again the combination of the functions of road surveyor and collector of taxes, and in another instance the surveyor is also a farmer. Can you expect to get uniformity of road management from these gentlemen? I think it is impossible, and I hold it to be ridiculous for any County Council to say they would leave the power of managing roads open to such people. As to "lump sum contracts," what Mr. Robinson describes in his paper, we tried to do, but I am sorry to say that in this county such contracts have not been a success. The idea is good, but in practice it does not turn out so satisfactory. If the Act would allow you to contract and to make proper specifications no doubt any difficulty might be overcome; but the Act does not allow you to so contract—that is to say, we have been advised by two eminent lawyers that it is impossible legally to contract with a specification. If the Act could only be amended so as to enable the County Council to lay down terms of contract, I feel confident that we should not have anything like the number of disputes that now arise. Mr. Robinson says, "With regard to urban authorities, it has been mentioned they have all claimed to retain, and therefore it is necessary to agree with them as to the amount to be contributed by the county towards the cost of the maintenance and repairs, and reasonable improvement connected with the maintenance and repair of the respective roads." That dreadful "towards!" I should like to know where you are going to draw the line where sanitary work ceases and non-essential road-making begins. The most reasonable way to deal with the matter, it seems to me, is to go into the figures with the local surveyor. Put yourself in the place of the local surveyor and just ask yourself this question: "If I have to maintain the roads for a reduced amount, what item of expenditure shall I leave out?" If you do that, I am sure that a great deal of the demand for reductions will cease. It is easy for a man to say to a local surveyor, "These are your accounts, I do not agree with them;" but it would be a very different thing to say what work you would pick out as unnecessary if you had to deal with the local roads yourself. As to failing agreement with the urban authority I do not see why there should be any failure to come to agreement. We have not failed. We have agreed with the local authorities, and if we can do that, why cannot others? Later on Mr. Robinson says, "There are urban authorities, and I am glad to testify to it, with whom it is not difficult to come to agreement," but he knocks that down at once by adding "but when these find others increasing their demands, and see the result, naturally, and it may be said, almost in self-defence, they are driven to a different course." That may be so, but I think it a terrible slur on towns in Hants that they should be guilty of such a mean trick. In this county we treat all the boroughs and towns fairly, and we find that they do not increase their demand in this way. Take the case of a colliery district in which there is a heavy amount of traffic. We prepare our estimates in conjunction with the local authorities, and they are paid according to the amount required for the maintenance of the road. Well, on the other side of the county we have an agricultural district, where there is a small amount of traffic. If the local authorities in that district acted in the manner ascribed by Mr. Robinson to the local authorities in Hampshire, they would say, "You are paying the colliery districts a lot; we must have larger payments from you." But they do not adopt that attitude. They know that we deal with them fairly and reasonably, and I have no hesitation in saying that if other counties do as we do, they in turn will be dealt with fairly and reasonably. As to the figures in the schedule attached to Mr. Robinson's paper, I think they are most interesting to Hampshire, but very uninteresting to any other county, because they are, I had almost said, unfair to another county. I have miles and miles of roads, which I should be glad to show to any one, which do not cost us 5*l.* a mile to repair, but it would be unfair to take such roads as those as samples of the roads of Notts. The roads must be regarded according to the amount of traffic over them. Therefore, although Mr. Robinson's figures are of interest to us for private purposes, they are of no use to us for our public purposes. I have long given up looking at other people's figures. Practical experience is better than all outside statistics or book-learning. I, for my part, am obliged to Mr. Robinson for reading his paper, as it gives each one of us an opportunity of airing his pet ideas on road maintenance.

Mr. J. T. **Eayrs**: As representing a county borough I can look upon this question without bias, for in West Bromwich we have no difference with the county. We have our own main roads, and there is no question of accounts, or of what we should or should not receive. Therefore we are in a happy position. The vexed question, it appears to me, between the counties and the local authorities is the question of the maintenance of footpaths. County authorities, so far as I can see, have not looked upon the question in the spirit in which the Local Government Act intended. There is no doubt whatever that Nottingham is far in advance of any other county in this respect; and I am very glad to see the liberal way in which they look at the question of the maintenance of roads in general and of footpaths in particular. The Warminster decision was a surprise to a great many county authorities, and even now there are many who will not recognise footpaths. The County Councils Association seem to me to be putting a premium upon litigation by offering a sum to any county who will fight the question over again. I think that is a very wrong principle to go on. If any county has a particular grievance with any urban authority, let them fight it out themselves, and not let an Association put a premium upon litigation by offering a reward to those who enter upon it. As to the reasonableness of the contention of urban authorities in regard to footpaths, there is no doubt that the footpath is as much a part of the road as the carriage-way. The public are entitled to use the whole of the road, and I cannot admit that the roads were made for carriages and vehicular traffic only. As to the permanent improvement of footpaths I think the counties do not look at the matter liberally enough. If they would only look at the question without prejudice they would see that in urban districts it is absolutely necessary to have permanent paving. In rural districts it is not so necessary. But where there is any amount of traffic a permanent pavement is essential. It certainly could not be held that because a footpath was gravelled or ashed, when a district was a small one, it should always remain so when the district grows. There must be a different kind of pavement when the district grows. The traffic demands it. If county authorities will only look at it properly they will find that the putting down of a permanent pavement will often result in a saving to them in expenditure of future maintenance. As to the class of pavement that should be used, that must depend upon the amount of traffic, and I think is a matter which may be very well left to the county surveyor and the local authority. On the other hand I do say this: no urban authority should spend money recklessly on permanent pavements. Even where the improvement is a desirable one the authority should not go and lay down a large quantity of permanent pavement without acquainting the County Council of their intention; and I think that a conference between the county surveyor and the local surveyor as to the amount of work that should be done during the year would very often lead to an amicable agreement. It would be manifestly unfair on the part of the urban authorities if, when one authority started it, they all went and put down pavement throughout the whole of their districts. The County Councils could not stand that. Whatever is done in the way of paving footpaths should be done gradually and under an amicable agreement between the county and local authorities.

The President: With regard to the remark made as to the County Councils Association having offered a premium to litigation, Lord Belper informs me that the money has been subscribed solely by the counties interested in fighting these cases.

Mr. Eayrs: I am obliged to you, sir, for the correction. It does not, however, alter the fact as to the premium being offered.

Mr. R. J. Thomas, Buckinghamshire (county): I also have to thank Mr. Robinson for his paper. It opens up a very valuable discussion, and brings us to the point of dispute between county and urban authorities. Prior to the passing of the Local Government Act, there seems to have been a general impression that footpaths did not form part of main roads. That view has been knocked on the head by the decision in the Warminster case. It is reasonable that after the Warminster case we should take it that a main road in county districts is from hedge to hedge, and in towns from house front to house front. In Buckinghamshire we have taken the rural main roads into our own hands, and have acknowledged our liability for footpaths in urban districts to the extent and condition in which we found them. Where improvement was suggested—for instance the substitution of Victoria paving for tar paving, or where any increased expenditure of a like nature was involved—we arranged with the urban authorities what we should pay for the improvements; and I think the word "towards" comes in very properly there. If you are going to effect an improvement in the quality of your pavement, you have to come to an arrangement with the authority, and the Council I serve thought it well to instruct me to meet the urban surveyors personally, and talk the matter over in a friendly and amicable spirit. Whenever that course has been adopted we have had no friction whatever. In one case—I will not name the authority, but I have the particulars here—I was instructed by the Highways Committee of my Council to consult the local surveyor. The local authority sent in a claim for 319*l.* for half a mile of main road. Before any arrangement was come to the Highways Committee of the County Council invited all the urban authorities to a conference to discuss the sum to be paid for main roads. Before meeting the Highways Committee the urban authorities held a caucus meeting, and arranged, upon the advice of a clerk to a local board, to claim the whole cost of the roads. At the conference the urban authorities would hear no reason, and their spokesman said, "We must have the entire cost or none at all," and they then left the room. I was instructed to examine the claim I have mentioned, analyse it, and report upon it, and to see the local surveyor. I went down to do so, but found that he was instructed not to see me, and I was told to make any communications I had to make to the clerk, who was a solicitor. I was further informed that the authority had sent in their claim and declined to give me any further particulars. I analysed the claim as best I could and I certified for 216*l.* An arbitration took place and continued for two days, with the result that while the authority claimed 319*l.*, and I had certified for 216*l.*, 203*l.* was awarded. So you see that the spokesman of the urban authorities, who was the clerk of this urban authority, was wrong, and that clearly there must be something in the word "towards." If county and urban surveyors are permitted by their authorities to meet each other in a friendly spirit without any bickering, or any false notions about "cutting each other's throats," these questions can be easily settled. Surveyors are buffers between the authorities they serve and the ratepayers; they get hard knocks, and however many they receive, they have to grin and bear them; but surely life is not worth living if they have to be constantly attempting to cut each other's throats. I think Mr. Robinson was handled rather roughly in regard to one statement he made. The gentleman who criticised Mr. Robinson remarked that Mr. Robinson said footpaths were not recognised in Hampshire as part of the main roads, but Mr. Robinson did not express an opinion either way. He said, "Rightly or wrongly the county authority declined to recognise footpaths by the sides of the roads, and the local authorities acquiesced therein." I think it only fair that it should be pointed out that Mr. Robinson does not lend himself to that view at all. There is another thing which would simplify matters very much. Mr. Robinson says, "Claims are submitted and examined in the light of the previous expenditure as shown in the accounts before mentioned; offers are then made of such sums that are considered to be sufficient to keep the roads in sound repair, irrespective of such watering, cleansing, &c., beyond that really necessary for maintenance." I must differ very much from Mr. Robinson there. I do not think you should pay according to an estimate. I think the payment in full discharge to an urban authority should be on the actual cost. It would not be fair to either party to pay on an estimate. At Christmas time we have particulars prepared of what has been spent during the past nine months and an estimate of what will be spent in the next three months. We pay on account. In Buckinghamshire we agree with Lord Belper that it is illegal to pay on account, but we hold that it is desirable to do so. The chairman and members of my committee know that it is illegal, but still think it very wrong that the urban authorities should have outstanding such a large amount of money to which they are really entitled for work done. We pay on account and the Local Government Board auditor pulls a very long face, and you gentlemen know what these auditors are. At any rate he has passed the accounts hitherto, and so far we are happy. The urban authorities have the interests of the ratepayers at heart, and they know they must not go to excessive outlay without due reason and consideration. I think it should be pointed out that there are occasional complaints about the main roads which are maintained by County Councils; but the fact remains that for two or three years before the County Councils came into existence the roads were very much starved by the parishes who knew what was coming. In the case of one parish, near Uxbridge, the surveyor himself told me that he had not spent a penny upon the roads for two years before the County Council was established. In fact it appeared that he had scraped and sold enough sand from the road to pay for the material he had put on it. The result of that economy has been that I have had to re-pitch the whole road, and to steam roll it at great expense, and even now it is not at all what it should be. I am sure of this, that, whether the old proverb that the infernal regions are "*paved with good intentions*" be true or not, main roads are repaired by the County Councils with the best intentions, plus sound materials, fairly paid labour, and the most equitable arrangements that can be come to between urban and county surveyors.

Mr. T. L. Lewis: I, unfortunately, am one of those buffers that have been referred to, and what I have to say is really in opposition to what has been adduced by county surveyors generally, and will be entirely on the other side of the question. My district comprises 3½ miles of main roads, situated in the county of Gloucester, adjoining East Bristol, and unhappily my board have been in conflict with the county authorities ever since the commencement of this Act. My 3½ miles of main roads during the past year have cost me 2100*l*., and the sum which the County Council have been good enough to send us during the last week was 1165*l*. Well that leaves a very heavy balance against me; I sincerely trust that the result of our meetings here and at other places will be to bring the county surveyors and the surveyors of the urban authorities into closer touch. I really think that is the first step to be considered. I am very pleased to find that the county of Nottingham, in which we are assembled to-day, stands pre-eminent in this matter. Referring particularly to the paper which has been read by Mr. Robinson, there are one or two good points in it, but there are others to which I take some exception. I do not think myself that the county authorities could carry out the maintenance of main roads in urban sanitary districts like my own, which is situated between the great city of Bristol and three small towns, one of which is an urban sanitary authority. There are no railways in the district, and a considerable amount of traffic is carried over my roads, for which I receive no credit from the county authorities. The county authorities certainly have a priority over the local authorities, which we do not for a moment contest, but they ought not to forget where the money comes from. In my district, which is very large in population but not in rateable value, the County Council have during the last three years trousered about 2000*l.* to the good, which we are rather sore about. I am very sorry to say that the Act seems to be a fruitful breeder of discontent, and no doubt during the coming year we shall see a great many arbitrations by the Local Government Board. I was engaged in one in Somersetshire in January last, in which thirteen urban sanitary authorities—that is to say all of them—disputed the amounts. We had our friend Mr. Codrington down there, but his report is not yet published, though it is looked forward to, and will doubtless be interesting to both the county and the urban sanitary authorities. I think the discussion of matters like this main roads question is of considerable importance to all of us, and I trust it will be settled amicably between us, and that we shall not have recourse to the arbitrations which now appear to be coming upon us so thickly.

Mr. Eachus: I should like to say a few words with regard to this subject, and in the first place I should like to point out that local authorities labour under a disadvantage in the system of arbitration which is adopted under the Act. An arbitrator is appointed by the Local Government Board, and hitherto I think one inspector—the same inspector—has been appointed in every case. I have had to give evidence on the opposite side to Mr. Codrington in years past with reference to the cost of maintaining roads. Mr. Codrington's experience of road making was chiefly, I think, in South Wales, which, in those days, had nothing like the traffic even which it has at present, consequently we have as arbitrator an engineer undoubtedly of good experience and a most able arbitrator, but one who is if anything prepossessed in favour of what I may call cheap road making—that is of country roads. I hold that you cannot compare a country road with a town road, and that you cannot even compare one district with another without knowing all the circumstances of the case. You want, not only to know the width of the road, but the actual extent as well as the nature of the vehicular traffic. You also want to know the actual cost of materials and labour and the actual traffic, and I may add friction per super yard on the road, because if a road is 40 feet wide and is level, and has 100,000 tons a year going over it, that road is subjected to less wear and tear, and would not require the use of such expensive materials as a narrower road of say 15 feet width with steep gradients, even with the same amount of traffic.

Having touched upon the first question as to what ought to be the basis of allowance if one local authority is to dispute with another, I will first address myself to what is the burden of Mr. Robinson's paper. It appears to me that an excessive expenditure, or what is looked upon as an excessive expenditure in a particular district in the county of Hampshire, puts apparently at first sight an undue burden upon the county; but I think if we follow that a little further there is not the same justification for finding fault with an excessive expenditure in a particular district as may appear at first sight. If you have a seaside place which has to keep everything in first class order and has to cater for its visitors, I think the result of that excessive expenditure will probably be to bring more visitors to the district and to send up its rateable value, and although its roads will undoubtedly cost more in cleansing and in keeping a perfectly smooth surface than the roads of an ordinary inland district with a similar amount of traffic would cost, on the other hand you will probably have a higher rateable value to contribute towards the funds out of which the county grant will be paid. Another point that comes to my mind from the observations of the last speaker is that the neighbourhood of Bristol is very hilly, and the same amount of traffic on a hilly road will do more damage than it will on a comparatively level road. Whatever the district you must therefore take all the circumstances into account. I am quite at one with those who have advocated an amicable arrangement of these matters between the county surveyor and the local surveyor. I must say I think the work ought to be done on those lines. The county surveyor ought to know his work, and the local surveyor ought to know his work, and if two men who know their minds meet on a given subject, as a rule they can come to a reasonable agreement. I think Mr. Hooley put it very nicely when he said that when the county surveyor is disposed to dispute the account of a local authority, let him place himself in the shoes of the surveyor to the local authority, and strike out what he himself would leave out if he were doing the work.

Mr. R. F. Vallance: Representing one of the chief towns in the county of Nottingham, I should like to say one word on behalf of the urban authorities of the county. I desire to say that on the whole we are highly satisfied with the arrangements existing between the county and the urban authority. Personally I have never had the slightest difficulty in coming to an amicable arrangement as to the amount which should be paid to the authority I represent. As to footpaths we have always had an amount allowed for repair and maintenance, and also for improvements. When we have put down a new footpath where none had existed before, it has been taken into consideration by the county, and we have had from them, not the whole amount, but a grant in aid which has been satisfactory to the local authority. We have also had grants in aid of roads other than main roads, which are connecting links between the main roads, and those grants are equal to the total expenditure on keeping the roads in repair. This system works very satisfactorily.

Mr. A. T. Davis: I have great pleasure in rising to add my testimony to the value of this paper. I consider that Mr. Robinson has approached this question in a very conciliatory manner, and there is little in the paper that I cannot cordially endorse. The only point upon which I do not agree with him is where he expresses an opinion, that perhaps it would be well if the law were altered so as to allow County Councils to repair urban roads, direct or otherwise. I cannot agree with him there, perhaps because I have been in the position of surveyor to an urban authority, and I should have been very jealous indeed if the management and repair of the main roads under my care had been taken out of my hands. I think the urban authorities ought to have the repairing and entire management of their roads. Mr. Robinson may be considered fortunate in being surveyor to a county where the highway system has obtained for many years. The system seems to have been in existence in Hampshire for 30 years. In my county—Shropshire—the highway system obtained very largely; but, unlike Hampshire, no accounts were required to be submitted under the Highways and Locomotives Amendment Act, and when I went into the county I found no record of expenditure on the different roads. That placed me at a great disadvantage. Mr. Robinson was able to study records and to take into consideration the actual cost of roads for some years past, and though an opinion has been expressed by a previous speaker that estimates are not much good, I am afraid we could not do much in the matter of road making without estimates. I do think the average of past years is a very good criterion to go upon. Of course, in arranging with urban authorities, if any settlement of amount is based upon past experience, there should be a clause in the agreements allowing for any extraordinary traffic, or any improvement that may be considered "reasonable"—adopting the wording of the Act. I hope it will not be considered that I am at all jealous of the high praise that has been given to Notts or to our friend Mr. Hooley, the county surveyor of Notts, because I consider that Nottinghamshire and Mr. Hooley deserve everything that has been said in their favour; but I should scarcely like it to go forth to the world that Nottinghamshire is the only county that has come to an agreement in every instance with the local authorities. I am pleased to be able to bear testimony to the fact, that Shropshire has agreed in every instance with the local authorities, and I hope we may continue to work on amicable lines in the future. In fact, there is every reason why it should be so. I am inclined to take some credit to myself in the matter, inasmuch as I have been a member of this Association for many years in the capacity of surveyor to an urban authority. I think the fact of my having interchanged opinions with my brother members for many years at meetings like this has enabled me to look at matters which have come before me in my capacity of county surveyor in a different light to that in which they might, perhaps, have presented themselves had I not at one time occupied a position under an urban authority, and had I not had the privilege of belonging to this Association. The whole thing seems to me to turn upon that one point "reasonableness." The chord that Mr. Hooley struck, in fact, the whole tenour of his speech, seemed to depend upon that word. If urban and county authorities would approach each other in a reasonable spirit, and if urban and county authorities would confer in that spirit, I feel it would lead to an amicable arrangement being come to between the two authorities. Perhaps it would not be uninteresting if I gave a few figures with regard to my own county. Three years ago I found that the rural roads of the county were costing about 27*l*. per mile. The first year we worked on the average of the three preceding years, and that was the basis of contract between the county and the rural authorities. It was of course an absurd system to continue, and on my recommendation a fresh system was instituted the next year. Estimates were arrived at between myself and the highways surveyors, and these were taken as the bases of future contracts, and the charge in respect of the rural roads jumped up from 27*l*. a mile the first year to 31*l*. the second year, and then the next year to 34*l*. per mile. Two years ago we tried the experiment of direct management by taking over three highway districts, and forming those districts into a division. That experiment answered very satisfactorily, and on the 1st of April last the county took over other highway districts, making three divisions. At the same time they approved of a scheme which I drew up for dividing the whole county into six divisions. The first division that was taken over was in the south-western portion of the county — that was the experimental division. The two other divisions taken over are also in the south, so we now have the whole of the roads in the southern portion of the county under direct management. The northern portion is still under the management of the highway boards by contract, but that will cease to be the case in twelve months time, as the County Council have decided that the whole work of main roads shall be done direct from my office. I have divisional surveyors appointed in the three divisions I have mentioned. There is a steam roller in one division, and we are about to put a steam roller in each of the other two, and I hope when the whole six are taken over we shall have a steam roller in each of them. I trust that by this means in a few years time the roads will be considerably improved. Steam rolling, I can say, has, in our case, answered very satisfactorily. I may mention that the cost under direct management has increased from 34*l*. per mile—which was the average under the highway boards —to 39*l*. and some odd shillings per mile, so that there is practically an increase of 5*l*. per mile. That I think will be reduced again, as our roads are rural roads and do not require, or ought not to require, very much money to repair them when brought up to a proper standard. I have great hopes of being able in a few years time to reduce the expenditure to something like the figure I have mentioned, viz. 34*l*. per mile.

Mr. E. P. Hooley: The point raised and the figures given by Mr. Davis are interesting to me, as they show an increase in the cost of roads directly managed by the county. This year the estimate of my council has very much increased in consequence, mainly, of one road, and of the extra mileage put on for new main roads. I have now had two years of direct management. In the extreme northern part of the county we found the roads in about the most deplorable condition it was possible for roads to be in. There were large ruts in them and huge holes that a horse could hardly get out of if it once got in. There were mustard pots in succession all up the hills. Our estimate in respect of these roads—an estimate which will not be exceeded—is something like 700*l.* less than it was for the same roads two years ago. In addition to that we have used something like 2000 tons more material on those roads than was ever used before in late years. I think that rather bears out what I said just now as to county money going in the wrong direction. As to my remarks upon Mr. Robinson's paper I desire to say that I did not mean anything personal in what I said. The remarks I made were simply suggested to me by his own observations.

Mr. W. H. Leete: The Beds County Council have from the first interpreted the Act as including footways with the roadway, and have paid two urban authorities for the past two years at the rate of 8*d.* per lineal yard for flagged paths, 5*d.* per lineal yard for tar paving, and 1*d.* per lineal yard for gravel.

The total length of each class of footway is allowed at above rates as a capitalised sum of the cost of keeping the paths maintained with all necessary new paving in the various sections that yearly require restoring, also for general maintenance.

The rate per lineal yard will of course vary, as it may be near to or removed from the source of supply.

The average cost of roads must also vary considerably; those removed from the quarry districts, as Beds is, and not having any local material, are of necessity, much more costly. Granite in this county costs 13*s.* 9*d.* per ton delivered on to roads.

I fully agree with a previous speaker that averages are little or no guide, when material is obtained in some parts of the country at 3*s.* 6*d.* per ton, and others at an even higher rate than is paid in Beds.

My observations *re* recent Local Government Award must be taken as my own deductions, not having received any information from the Local Government Board as to the basis of their award, which over the sum voted by the Council amount to a total including works of new kerbing, channelling, pitched crossings and gully gratings, and drains thereto.

I may also state that the word "towards" is taken to mean, not payment in full, but in part; the urban authorities having claimed under the Act should, we think, share some part of the cost of such works as are particularly beneficial to urban authorities, and not shared by the rural districts.

The President: Before asking Mr. Robinson to reply I will put the vote of thanks which has been moved and seconded. I may say he kindly prepared this paper at my request, and I am very pleased that it has brought about a good discussion. If county surveyors who are specially interested in road maintenance would only attend the meetings of this Association more frequently, they would be brought into contact with the surveyors of the local authorities whom they have to meet in the ordinary routine of their work, which would no doubt facilitate the settlement of difficulties which often arise between the counties and the local authorities, because however anxious the authorities may be to come to an amicable arrangement amongst themselves, a great deal depends upon the officials who have in the first instance to consider the details and the estimates.

Mr. J. Robinson, in acknowledging the vote of thanks, said: My first duty is to thank you and the gentlemen who proposed and seconded the vote of thanks, for the kind way in which you have received this paper. I am deeply gratified to think that the object I had in writing this paper has been achieved. That object was to put before you certain views which would enable a discussion to take place, and lead to an interchange of opinion between county and borough officials. In attempting to reply to the points which have been raised I must make some apology to the meeting. I do not pretend to have such debating power as to enable me to deal as fully and as well as I should like to with all those questions. I should not like it to go forth that the Hampshire County Council is an unreasonable body. We, as you see from my paper, have arranged up to the present with eleven out of twelve urban authorities; one urban authority we have not arranged with. I should have liked to have said something about that, but, as a matter of fact, we have had one arbitration, and there are others pending, so you will see it would be scarcely right for me to say much on that point. Of course public bodies—county councils and local authorities alike—depend a great deal upon the advice given them by their officials; but still they do not leave all these matters to them. They do not, for instance, leave their officials to settle these road questions entirely; if they did, probably we should be able to arrange matters without so much difference of opinion as now takes place. We have to advise our authorities, and the authorities then act. You cannot always get authorities to look at things from the same point of view as yourself, and see things as broadly and liberally as you would perhaps wish them to do. With regard to footpaths and the remark that was made as to the Hampshire County Council not recognising them, I simply put in that paragraph to record a matter of fact in reference to the time before the passing of the Local Government Act, 1888. We did not recognise footpaths, and the local authorities acquiesced in that view, therefore, when the Local Government Act came into operation we proceeded on the same lines, and until the Warminster case was decided we thought we ought not to contribute towards the maintenance of footpaths. Now we find we must do so, and, as far as we possibly can, we endeavour to meet the local authorities in a fair and generous spirit. There was a remark made by Mr. Hooley with regard to grants in aid, and a paragraph of my paper in reference to the matter. Well, I simply point out that as a fact the permanent contribution which we now receive from taxation towards the county work was based on the actual expenditure on roads, in addition to the actual expenditure on other matters; therefore we in Hampshire who did not contribute, or did not pay towards footpaths, and did not spend a very large amount on our roads, received only in proportion to the amount we did expend. Now we have to pay more for our roads and footpaths, therefore we are in a worse position than those counties who spend more.

Lord Belper: Only partially. The new grants are paid in the grants formerly received, but there is an addition to that.

Mr. Robinson: Thank you. A suggestion has been made as to whether I could not give information in the schedule at the end of the paper as to the extent of traffic, the area of the roads, and so forth. Well, I should very much like to do so, and I think it would add very much to the value of the statistics if it were possible to do it; but in country districts it is practically impossible to obtain the information to put such a column in a schedule. There was another remark made with reference to dealing with urban authorities for the actual expenditure of the year. Our practice has been—and we so read the Act—that we must agree at the beginning of the year, and not at the end. We must come to an agreement with the urban authorities, and that being so, before we can come to an agreement we must have some figures from them as to what they think must be spent upon the roads during the year. The estimates are looked into, not in any carping spirit, the urban surveyors and myself come into conference with regard to them when necessary, and agreements are come to between the authorities as to the amount which ought to be allowed. With regard to the interpretation put by Mr. Hooley upon my remarks as to urban authorities being driven to increase their demands, I will first say I do not assent to it, but I will not enter further into the question. In conclusion, I must repeat my thanks to you for the way in which this paper has been received.

The President: It is my pleasant duty to ask you to accord a hearty vote of thanks to the Nottingham County Council for giving us the use of this room for our meeting to-day, and I may also add that the thanks of the Association are specially due to Lord Belper, the chairman of the County Council, for coming here to-day, and for his interesting remarks on County Council work. As Mr. Hooley has told you, his lordship's knowledge of the law enables him to grasp those knotty points which are inseparable from the working of a new system of Local Government. Under the able guidance of his lordship, the Nottingham County Council has led the way, and shown us how a settlement of the main roads question can and should be effected. I am very pleased to hear from Mr. Davis that the Shropshire County Council, has followed in the same lines, and has also arranged with all the local authorities. I can only hope that that course will become general.

Lord Belper, in acknowledgment, said: I will just thank you for the very kind manner in which you have acknowledged my presence here to-day, and I can assure you that I have taken very great interest in the discussion that has taken place. I am very glad that the Association has had the opportunity of coming here, and given us the advantage of hearing the opinions of gentlemen from so many parts of the country. I hope the result of the discussions will be that the local authorities throughout the country will meet in as conciliatory a manner as possible to discuss and determine differences when they occur. I also hope that when any opportunity occurs for effecting one of those changes in the law, which are constantly being made in county government, that a change will be made in the direction of giving greater latitude and greater power to local authorities to manage their affairs in their own way, and the way most suitable to their circumstances.

At the conclusion of the discussion of the papers the members were entertained to luncheon by Mr. Hooley, to whom a hearty vote of thanks was accorded for his hospitality. The members then proceeded by train to Mansfield, and from thence to Welbeck Abbey *(the seat of the Duke of Portland) by the way of the Dukeries, in open brakes. The drive is one of the most beautiful in the country, and, the weather being fine, was thoroughly enjoyed. On arrival at Welbeck Abbey the party were taken over the famous underground apartments, the conservatories, gardens, and stables, for which Welbeck is renowned among historical homes.*

DISTRICT MEETING AT PETERBOROUGH.

June 11th, 1892.

Held in the Guildhall, Peterborough.

T. De Courcy Meade, President, *in the Chair.*

The Deputy Mayor (Mr. Councillor Herbert) in welcoming the members of the Association, said: On behalf of the Mayor and citizens of Peterborough I give you a very hearty welcome to our city. While not having much to boast of in Peterborough we certainly have no apology to make, even to members from London and the larger cities of the Eastern Counties. Though we have not done all—or even one-half—that Mr. Walshaw and Mr. Gill would have liked us to do, we have done what we could to carry out sanitary science and to obtain an abundant supply of pure water for the city of Peterborough. The citizens were much indebted to the early members of the Corporation for the public spirit and enterprise they displayed, upon the incorporation of the city, in undertaking an efficient system of sewerage and the obtaining of a proper water supply.

The President having thanked the Deputy Mayor for the welcome accorded the Association, Mr. J. Barber proposed and Mr. Radford seconded the re-election of Mr. Buckham as Hon. Secretary for the Eastern Counties District. This was carried unanimously and Mr. Buckham, in again accepting the office, thanked the members for the confidence reposed in him. The following papers were read and discussed, and at the conclusion of the discussion which followed the papers, a vote of thanks was unanimously passed to the Mayor and Corporation of Peterborough for the use of the Guildhall for the purpose of the Meeting.

MUNICIPAL WORK IN PETERBOROUGH.

By J. W. WALSHAW, Borough Surveyor.

The Borough of Peterborough is situate on the banks of the river Nene, which divides it into two portions, the larger being in the county of Northampton, of which it forms the eastern extremity, and the smaller in the county of Huntingdon; it lies on the borders of the great Fen country, but is chiefly known on account of its grand old cathedral, the west front of which has been said to be the finest in Europe. Amongst other attractions within the cathedral may be seen the burial places of Queen Catherine and Mary Queen of Scots; some years after burial the remains of the latter were disinterred and removed to Westminister Abbey. The cathedral has recently been restored, and a visit will well repay those interested in architecture.

The population of the Borough at the last census was 25,172, being an increase of 4061 during the preceding ten years; the rateable value is 106,350*l.*

The main line of the Great Northern Railway passes through the town, and the Midland, Great Eastern, and London and North Western Railway Companies have joint stations here. The river Nene is navigable, and much timber and farm produce is brought by barges and discharged at the several railway wharves. It is due to the great railway accommodation that the town owes its prosperity. The trade is principally in malt, timber, agricultural produce and machinery, and the Great Northern Railway Company have engine works, and employ a large number of men.

The town obtained a Charter of Incorporation in 1874, previously it was governed by Improvement Commissioners. Upon coming into office the newly-formed authority found sanitary matters in a deplorable condition, especially in those parts of the Borough which had not been included within the Commissioners' district; hundreds of houses were drained into cesspools, privies running into open vaults, and the water supply to the whole Borough was taken from wells, many of which were not more than eight feet deep and in close proximity to cesspool and privy vaults. There were twelve public pumps in the centre of the town, the whole of which, with one exception, have been put into disuse; they are available, however, in cases of emergency. So far there has been no occasion to use them.

Upon coming into office the Town Council took immediate steps, both with respect to water supply and drainage, and called in Mr. J. Addy, C.E., to prepare a scheme and report upon the subject; these were adopted, and the works proceeded with without delay. At that time the sewage ran into the river, and the authorities were threatened with an injunction to restrain them from permitting this to be continued.

The sewers are laid in a straight line, with manholes at junctions and regular intervals; the inclinations are fairly good, with the exception of that of the intercepting sewer, part of which has a fall of 1 in 2249, and requires periodical attention.

All the old sewers, where practicable, have been retained for surface-water and they are also used as storm overflows.

The sewers are ventilated by open manholes at street levels; they are flushed by means of wooden discs, which are placed in the block on the outlet side of the manhole and allowed to remain there until the water, which is run in from the town mains at various points, rises to a considerable height, the disc is suddenly withdrawn and a good flush obtained; a large quantity of fresh water is also run into the sewers which is not held up. Notwithstanding these arrangements, we have, especially in the autumn months, complaints of smells arising from the manholes; this however is the general experience where similar means of sewer ventilation are adopted. Several cast-iron shafts, varying in diameter from four to six inches, have been erected against buildings and trees; where these shafts are fixed near to the manholes they are often the means of preventing the escape of offensive smells from them, but this is not the case where they are more than ten or twelve yards away.

The sewage is treated by broad irrigation on a farm containing 300 acres, and situate about half-a-mile from the Borough boundary; the whole of it reaches the farm by gravitation, that from the Huntingdonshire part of the Borough, and from a low-lying portion on this side of the river, has to be pumped upon its arrival there. Upon reaching the farm the sewage runs into two small tanks with gratings fixed at the outlet end to prevent paper and other solid matter passing on to the land; from the tanks it is carried through the farm by open concrete conduits, and distributed upon the land by slackers with sliding doors.

The straining tanks are emptied every three weeks, the mud is thrown into pits having earth sides, it is turned from one pit into another, and thus becomes stiff enough to cart away; as a rule the author finds a sale for the sewage mud at 3*d.* per cartload, occasionally it is given away,

About 100 acres of the farm are grass, of which 70 acres are let annually from April to December, at an average rental of 5*l.* per acre, and 30 acres are kept by the Corporation for grazing and hay for the horses belonging to them. Willows are grown on 21 acres, some of them are sold on the land at 10*l.* to 11*l.* per acre, such as not so disposed of are cut and peeled by our own workmen, and a ready sale is always found for them at a price of about 12*l.* per ton on rail here.

Rye grass is grown upon about 20 acres; much of this is cut green, carted to the Corporation yard, and sold at 4*d.* per sack, that not cut for sale is made into hay, but the hay so made is not of very good quality. The remaining portion of the farm is under cultivation and we grow fine crops of wheat, oats, beans, mangolds, potatoes, &c. Our last year's farming operations were very successful, the profit, not allowing for interest on capital borrowed for the purchase of the land and laying out the same, was 1030*l.*, this left a balance in hand of 145*l.* after paying all pumping expenses and for sewage distribution, &c.

The farm cost 132*l.* per acre, and the sum of 6000*l.* has been spent upon it in roads, laying out, conduits, levelling, &c.

ROADWAYS.

There are about 30 miles of roadway in the borough, of which 1¼ miles are paved—5¼ miles are main road, the cost of maintaining which is paid by the County Council of the Soke of Peterborough.

About forty-five years ago the central part of the town was paved with random granite setts laid on sand, with joints filled in with similar material. The paving was in a bad condition before the commencement of the drainage and waterworks excavations, but matters were made much worse by reason of the numerous disturbances of the old setts; for some years the Town Council were desirous of improving affairs, but their borrowing powers were exhausted, and the work had to be delayed.

The first new paving to be executed was in 1884, when, as an experiment, about 600 yards of wood was put down in a narrow, busy street; the system adopted was similar to that at Norwich, viz. without a concrete foundation, the cost was 5*s.* 6*d.* per yard; the paving gave great satisfaction, and was renewed last year, after having been down seven years; the total quantity of wood paving here is about 2500 square yards. In a portion of one of the streets so paved creosoted blocks were used; they are an improvement upon ordinary deals, but they have not been down sufficiently long to enable me to give a decided opinion.

In 1888 powers were obtained for borrowing the money required for repaving the remaining portion of the then paved streets with 5 by 3 granite setts laid on 6 inches of cement concrete, grouted in with pitch and oil; the works were extended over a period of two years, and the sum expended was a little over 8000*l.* The whole of the materials were contracted for, the paving done by the square yard, and the rest of the work executed by the Corporation workmen. The cost was between 10*s.* and 11*s.* per square yard. Those acquainted with the streets of Peterborough three years ago cannot but be struck with the altered appearance of them to-day.

We have put down two short lengths of tarred macadam—one with granite, the other with slag; that of the latter material has been the more successful, and the author is about to extend it.

A 12-ton steam roller is used on the macadamised roadways.

FOOTWAYS.

Whilst the paving works were in progress new footways were put down in the same streets; they are of concrete, with 12-inch by 6-inch granite edging. The bottom layer of the concrete is 2½ inches in thickness, and composed of four parts local gravel to one part Portland cement; the top layer is ¾ inch thick, and consists of one part Portland cement to two parts gravel; several materials have been mixed with cement for the top layer, viz.:—Slag, granite, and gravel; that made with slag is the most durable, but its slipperiness is objectionable, and the author has discontinued using it; the best material is local gravel, free from sand, and granite sand in equal quantities. The work is carried out by our own workmen, and the cost is about 2*s.* 6*d.* per square yard.

The main portion of the other footways is formed of tar and gravel, with 12-inch by 3-inch York edging; they cost 1*s.* 3*d.* per square yard.

The Corporation have twelve horses in their town stables, these are supplemented by teams from the farm, and others are hired as required at 6*s.* 6*d.* per day for horse, cart, and man.

BUILDING BYE-LAWS.

Two years ago the "Model Building Bye-Laws" were adopted. They have effected a great improvement in the smaller class of dwelling-houses, both with respect to the thickness of walls and amount of open space required; a few of the clauses are felt to be stringent, more especially that with respect to the thickness of walls of houses where the space within the roof is so constructed as to be used as a box or lumber room. It appears to be somewhat excessive to require the walls, for their full height, to be increased in thickness from 9 inches to 13½ inches when the space intended to be utilised in the roof does not necessitate the walls being of a greater height than they would otherwise have been.

HOUSE REFUSE.

A periodical removal of house refuse is in operation in the Borough—there are two collections weekly in the centre of the town and one collection elsewhere—the average number of loads collected weekly is 90, and the number is increasing. The author regrets to say that the disposal of the collected matter is not so satisfactory as the collection, for it is deposited in disused gravel pits, &c., a great part of which will some time or other become building land.

COTTAGE HOSPITAL.

Eight years ago a Cottage Hospital for cases of smallpox only was erected on the sewage farm; during that period it has only been used on five occasions, one of them of recent date.

The rural sanitary authority have joint use of the hospital for which they pay a yearly rental of 30*l.*; the cost of it was under 500*l.*, and it will accommodate eight patients. We in Peterborough have great reason to congratulate ourselves upon our comparative freedom from this terrible disease.

We have a Goddard and Massey's disinfecting stove at our store yard; it is used after all cases of infective disease, free of charge.

The average death rate of the Borough for the past ten years has been 14·7, for the previous eight years the average was 20·7.

The Compulsory Notification of Diseases Act is in operation here.

PUBLIC LIBRARY.

The Public Library Act has been recently adopted, a suitable building has been taken on a seven years' lease and is now being fitted up at a cost of about 400*l*.

PUBLIC LIGHTING.

The gasworks are in the hands of a company, they supply and erect the public lamps wherever required, at a distance not exceeding 60 yards apart; the price of gas for public purposes is 3*s*. 2*d*. per 1000 cubic feet, for private purposes 3*s*. 4*d*. There are 642 public lamps, of which 59 consume from 14 to 21 cubic feet of gas per hour, the remainder are regulated to consume 5 cubic feet each per hour; the charge for cleansing, lighting, and maintaining the ordinary lamps is 15*s*. each per annum, and the larger ones 20*s*.

About one-fourth of the total number of lamps are not lighted during the summer months and moonlight nights, excepting when such nights fall upon a Saturday or other special occasion.

Last year the Bill for Public Lighting amounted to 1847*l*.

CATTLE MARKET.

The cattle market is owned by the Corporation; they purchased it about 18 months ago at a cost of 15,000*l*., and have found it a remunerative investment.

MUNICIPAL BUILDINGS.

The author cannot ask you to congratulate Peterborough upon the character of its municipal buildings; this is our Guildhall—our offices are scattered about here and there—we have expended all our means upon more urgent matters. It is, however, hoped that when next the Association visits Peterborough, which the author trusts may be at no distant date, the meeting may be held in a building of a more pretentious character and more befitting the dignity of a corporate town.

THE WATER-SUPPLY OF PETERBOROUGH.

By JOHN C. GILL, Assoc. M. Inst. C.E., Waterworks Engineer to the Peterborough Corporation.

Peterborough was incorporated as a municipal borough in 1874, and previously to this date the water-supply, derived from shallow wells, was insufficient and impure. The Improvement Commissioners, as the urban authority, before the town was incorporated, had been compelled to consider the advisability of providing an adequate supply of pure water from some extraneous source, but no active steps in this direction had been taken. In the meantime outbreaks of zymotic diseases were frequent, and could be distinctly traced to the presence of organic impurities in the water used for domestic purposes.

The Corporation, with admirable promptitude, determined immediately upon its establishment to introduce simultaneously an abundant water-supply and a new system of drainage, and in August 1874, within six months of the date of the Charter of Incorporation, instructions were given for the preparation of schemes for both purposes. The water-supply then introduced and since extended is the subject of this paper.

Summary of Works.

The works, which were opened in 1879, consist of:—

1. A pump-well 63 feet deep, 5 feet 6 inches in diameter.
2. Three 6-inch tube-wells discharging into pump-well.
3. A pair of 120 horse-power rotary beam engines.
4. Four pumps of the bucket and plunger type.
5. Two "Lancashire" boilers—shell 26 feet long by 7 feet diameter.
6. Buildings, consisting of engine-house, boiler-house, stores, workshop, and engineers' cottages.
7. A rising main, from pumps, 7 furlongs in length.
8. A covered reservoir, of one million gallons capacity.

9. A delivery main, 18 inches in diameter and 14 miles long.
10. Thirty-three miles of distributing mains.
11. The necessary valves, hydrants, wash-outs, and fittings.

The total cost of these works has been 21,118*l.*

THE WATER AND ITS SOURCE.

The water is drawn from wells sunk in a piece of land adjoining a branch of the Great Northern Railway, in the parish of Wilsthorpe, Lincolnshire, about three miles from Bourne and 14 miles from Peterborough. The original well from which the water is pumped is 5 feet 6 inches in diameter, lined with cast-iron cylinders, and when the yield from this well became, through the increased requirements of the Borough, inadequate for its supply, three 6-inch tube wells were sunk, from which the water is discharged into the original pump-well. The wells penetrate the Oolite formation and strike the water-bearing strata at an average depth of 53 feet 6 inches from the surface. From this depth the water rises with considerable force, in one instance a stone weighing $6\frac{3}{4}$ lb. was ejected from the top of one of the tubes. Before reaching the water a bed of argillaceous limestone, 8 feet thick, abounding in marine fossils, was passed through, and between this rock and the water-bearing strata the estuarine clays, 27 feet in thickness, were pierced. The first experimental boring was made in 1875, and on the 6th September in that year the water rushed up the bore hole in large volumes, and was projected in the form of a fountain to a height of 15 feet above the surface. The yield on the 21st of September, fifteen days after being first tapped, was at the rate of 420 gallons a minute from the 4-inch bore, and gave a velocity of 770 feet per minute at 3 feet above the surface.

The original pump-well, 5 feet 6 inches in diameter down to the water-bearing rock, and thence continued by five 6-inch bore-holes, gave sufficient water until the year 1885, when, because of contracts entered into for supplying the railway companies, additional sources of supply became necessary. Three tube wells were therefore sunk with a bore of 6 inches in diameter down to the water-rock, and continued to a distance varying from 9 to 15 feet in the different wells, with a diameter of 5 inches. A solid drawn copper tube lines the bore down to the water-rock, into which it is sealed. At the top of each tube a stop-valve is fixed, and by this means the quantity of water drawn from the wells may be regulated according to the consumption in the town. When only one of these extra wells is required the other two may be shut off entirely, thus preventing the water running to waste. The daily yield of these three 6-inch tube wells, gauged on the 12th November, 1888, was as follows:—

	Gallons.
No. 1 well	674,818
No. 2 „	681,108
No. 3 „	810,320
Total	2,166,246

The cost of the three wells, including all labour and materials, was 649*l.* 13*s.* 11*d.*

The total quantity of water drawn from all the wells during last year was 511,546,255 gallons, or an average throughout the year of 1,401,498 gallons a day.

The Engines, Pumps, and Boilers.

The engines are of the rotary beam type, with single cylinders 32 inches in internal diameter, and 6 feet stroke of piston. The steam and exhaust valves are gun-metal, of the ordinary double-beat equilibrium type; the various grades of expansion being obtained by making the cams for operating the steam valves with an increasing tread, so that by sliding them on the shaft by means of suitable screws and gearing, which may be operated while the engine is in motion, the valves may be kept open for a longer or shorter period of admission of steam, and the speed of the engines thus regulated. Each fly-wheel is 20 feet in diameter, and weighs 20 tons. The crank-shaft where in fly-wheel is 15 inches in diameter, and 12 inches at the necks. The throw of the crank is 3 feet. The beams are of wrought iron, 24 feet in length, and 4 feet in depth at the centres, the rolled plates of which the beams are formed being 1½ inches thick. To each beam are connected the rods of two main water pumps, condenser air pump, feed pump for boilers, and air pump for charging air vessel.

The main pumps, four in number, are of the bucket and plunger type. Each pump has a cylinder 1 foot 5½ inches in internal diameter, with a stroke of 3 feet. The bucket is made of gun-metal with a valve of the double-seated equilibrium type, with white-metal seatings. The diameter of the plunger is 1 foot ⅜ inch. The pumps draw their water through two suction pipes—the two pumps on each engine being fed by the same pipe. These pipes are 1 foot 6 inches in bore from the wells to the outward pumps, and 1 foot 3 inches from the outward to the inward pumps. All the pumps deliver their water into the same delivery main which conveys the water direct to the town, the surplus over the consumption being accumulated in the reservoir.

Two boilers of the "Galloway" type supply the steam for actuating the engines. The shell of each is 26 feet long by 7 feet in diameter. They are fed by water from the condenser hot well, which is at a temperature of 95° to 100° Fahrenheit when it enters the boilers.

The engines, pumps, and boilers were made and erected by Messrs. Galloway and Sons, of Manchester, whose contract was 9000*l.*

The Reservoir.

The Reservoir is constructed on Olthorpe Hill, an elevation about seven furlongs from the pumping station, having a summit level of 160·2 feet above Ordnance Datum. It is a brick structure, encased in concrete, and made water-tight with an outer shell of puddle. The covering is formed by segmental brick arches, springing from transverse walls, built with arched openings upon piers. The floor is of concrete, finished smooth with cement. The reservoir is rectangular in plan, 120 feet long inside, by 89 feet 6 inches wide, with a depth when full to overflow level of 16 feet, and a capacity of one million gallons. The height of water in the reservoir is shown on a dial at the engine-house by means of an electrical water-level indicator supplied and fitted by the Silvertown Company. The overflow level of the reservoir is 135·1 feet above the ground level at the Guildhall, Peterborough.

The cost of the reservoir and fittings was 7356*l.* 12*s.* 9*d.*

Delivery and Distributing Mains.

The 18-inch delivery main, 14 miles in length, is laid in all the straight sections with pipes 12 feet long, with bored and turned joints, in other parts the ordinary lead joint is used. The price per ton for the ordinary cast socket pipes was 5*s.* less than for those with bored and turned joints, yet the extra labour and materials used in making the lead joints caused the total cost of the finished main to be 1*s.* 4*d.* per yard run higher where the lead joints were used than in the lengths laid with pipes that were bored and turned. The bored and turned joints were used entirely throughout the delivery main, except at the bends, and have been eminently satisfactory during the thirteen years the main has been in work.

The distributing mains, 33 miles in length, are of various sizes, from 12 inches down to 4 inches, and are connected up in circuits so as to avoid dead ends as much as possible. Fire hydrants are fixed at an average of 90 yards apart, and sluice valves at all junctions and other places where required.

The contract for supplying the pipes was let to Messrs. Cochrane, Grove & Co., of Middlesborough, and the sluice valves, hydrants, &c., were supplied by Messrs. Alley & MacLellan, of Glasgow.

The total original cost of the delivery main was 36,456*l.* 13*s.* 4*d.*, and of the distributing mains 16,654*l.* 1*s.* 1*d.*

CONCLUSION.

The district supplied by these works comprises several villages adjoining the main pipes, or the boundaries of the Borough, and contains altogether a population of 29,300.

The four railway companies who have works at Peterborough are supplied from these waterworks, and together consume about 750,000 gallons a day.

The total daily consumption of water taken on an average throughout last year was 1,401,498 gallons. Excluding the water sold in bulk to the railway companies, this gives a daily consumption of 22 gallons a head for all purposes.

THE SHONE SYSTEM OF TOWN DRAINAGE.

By ISAAC SHONE, C. & M.E.

Although much has been written, printed, and spoken about this system, yet it is feared that there are still to be found Municipal Engineers, Surveyors, Architects, Medical Officers of Health and others interested in sanitary engineering works, who are more or less imperfectly acquainted with its principles and *modus operandi.*

He, the inventor of the system, is therefore much obliged to your Honorary Secretary for the Eastern Counties, Mr. E. Buckham, M. Inst. C.E., for inviting him to read a paper on it to-day to the members of your Association.

The author assented all the more readily to prepare this paper, because he is satisfied that your District Secretary (having investigated the system for himself, and having, as the result of that investigation, recommended the Corporation of Ipswich to adopt it, in connection with the drainage of Stoke, which is a part of Ipswich, and for which it was deemed by him to be specially suitable), as an honest conscientious engineer, became anxious that the merits of the system should be communicated, if possible, to his co-workers in this Association through the medium of a short paper upon it. At all events, this is the author's explanation of the reason why he has the honour of appearing before you in Peterborough to-day.

The author contends that by the aid of this system house-drains and sewers can be laid in low-lying, flat, and tide-locked habitable areas, on the most perfect hygienic principles which it is possible or necessary for the practical sanitary engineer to carry out. Not only can drains and sewers be laid down by hydraulic and sanitary rules in low-lying, flat town areas, but they can also be so laid, by the aid of the system, in undulating town areas, in an endless variety of ways.

A few engineers in the past, strange to say, treated the Shone system as if its object was simply to lift sewage in opposition to the most economical pumps extant; and, accordingly, these gentlemen entered into elaborate calculations to try to prove, to their own satisfaction at least, that lifting sewage by compressed air was less efficient than lifting it by steam power direct in the ordinary way. The inventor remonstrated too often in vain with these engineers who elected thus to regard the system. But happily the discussions which have arisen from time to time between its advocates and opponents have greatly helped to elucidate the intrinsic merits of the system. The process, however, of silencing prejudiced and incompetent critics, and converting opponents into supporters, has been as long as it has been painful and laborious. But the author is now thankful to say that at last he is no longer under the the necessity of defending the system against the attacks of opponents. The fact is, they have all caved in and disappeared before the indisputable evidences which have been afforded from time to time by the numerous and various works carried out on the system, in support of the claims originally set forth in its favour.

The primary object aimed at with the Shone system, is to get as high a degree of *sanitary efficiency* in connection with the every-day working of house-drains and sewers as is possible. The question which relates to the difference between the cost of lifting water by steam pumps, and ejectors worked by compressed air,* is one of secondary importance. The ejector system may in certain cases involve you in the purchase of a little more fuel per annum than a steam pump, but on the other hand, comparatively large and deeply laid sewers, discharging into one steam pumping station, would be more costly initially and annually, and they would involve you in a larger number of sewage-gas nuisances, and withal a larger number of preventible deaths, than would obtain by dividing a town or district into a number of separate automatic drainage districts on the Shone system. In one case, which the author investigated thoroughly, he found that the first cost of a most imperfect gravitation scheme which was executed in a small sea-side town in the United Kingdom, exceeded the estimated first cost of applying the Shone System there, by over 20,000*l*. He also found that the estimated annual cost of attending to and working the gravitation scheme exceeded the estimated annual cost of the fuel stores, and attendance required to operate the Shone System. According to this testimony, the ratepayers of the unfortunate town referred to, agreed to pay for 30 years 1087*l*. per annum in the shape of interest and amortisation for the 20,000*l*. wasted in executing drainage works which are incomparably inferior to the drainage works of the Shone System. The author regards his ejectors more in the light of life-saving apparatus than as economical sewage lifters; because we are told by the highest medical authorities, that decomposed putrid sewage, whether it be in vertical or horizontal cesspools, gives off gas which is prejudicial to public health; that foul drains, sewers, and cesspools cause an incalculable number of preventible deaths and cases of sickness. No sanitarian will attempt to contradict this statement in these days; and yet it is surprising to observe with what comparative indifference, even professional sanitary engineers occasionally treat those who venture to propound simple, scientific and practical remedies for the prevention of unsanitary drainage and sewerage works. You all know that *the only effectual way to place house-drains and sewers in a satisfactory sanitary condition, is to cause them to be self-cleansing and to be properly ventilated.* You also know that in order to render drains and sewers, carrying sewage, self-cleansing, they ought to be adjusted in size and inclination to suit the volume of sewage which they are intended to carry, so that the velocity of the sewage when the period of maximum flow obtains, shall be, if possible, 2·5 feet, but never less than 2 feet per second. If we call the 2·5 feet 100 per cent. then it is evident that 2 feet would only be $\frac{2 \cdot 0 \times 1000}{2 \cdot 5} = 80$ per cent. In other words, no drains or sewers should be designed or carried out which would permit of the velocity efficiency being less than 80 per cent. of the 2·5 feet per second—the velocity now universally considered to be necessary to render drains and sewers self-cleansing. Drains and sewers thus designed, if they are also efficiently flushed and ventilated, will be as reasonably perfect from a sanitary point of view, as it is possible and necessary for the practical municipal engineer and surveyor to make them. If drains and sewers are not thus designed, they will become drains and sewers of deposit, and consequently unsanitary.

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* See Professor Unwin's opinion, on page 231.

The velocity of 2·5 feet per second, however, applies only when drains and sewers are used for the carrying of sewage proper, on what is called the "separate system." When drains and sewers are used as the carriers of sewage and rainfall, on what is called the "combined system," a greater velocity than 2½ feet per second must be ensured, to preserve them in a self-cleansing condition; because the rainfall carries with it road *detritus*, and this adheres more or less tenaciously to the drains and sewers, and, by degrees consolidates on their inverts, rendering the process of self-cleansing impossible, even by the most systematic and liberal use of flushing water.

Mr. Julius Adams, C.E., Chief Engineer to the Board of City Works, and Consulting Engineer to the Board of Health, Brooklyn, U.S.A., states in his book on 'Sewers and Drains of Populous Districts' (after acquiring considerable experience of town drainage, on the combined system): "As easily carried in memory, the following will represent about the falls which will preserve circular sewers free from deposit, provided they run half full":—

For	6-inch	diameter	a grade of	1 in 60
„	9 „	„	„	1 in 90
„	12 „	„	„	1 in 200
„	15 „	„	„	1 in 250
„	18 „	„	„	1 in 300
„	24 „	„	„	1 in 400
„	36 „	„	„	1 in 600
„	42 „	„	„	1 in 700
„	48 „	„	„	1 in 800

Here we see Mr. Adams's practical experience tells him that a sewer which is used for both sewage and rainfall, even in comparatively well scavenged towns, must have a grade which shall be sufficient to give a velocity, when the sewer is half full, equal to about 3·75 feet per second, which is 50 per cent. *more* than we consider necessary to render *sewage sewers* self-cleansing.

It will be interesting, not to say instructive, to compare the gradients at which Mr. Julius Adams considers the following sized sewers should be laid, on the combined system, with the gradients at which they might be laid, to insure a velocity of 2·5 feet per second on the separate system, i. e. according to the author's improved Hydraulic Sewerage Tables which are now in the press, and which will shortly be issued to the public.

	Combined System. 1 in	Separate System. 1 in
6-inch sewer	60	150
9 „ „	90	248
12 „ „	200	350
15 „ „	250	458
18 „ „	300	570
24 „ „	400	805
36 „ „	600	1309
42 „ „	700	1575
48 „ „	800	1849

The foregoing comparison shows that the difficulties in the way of an engineer draining a low-lying, flat town of any extent, of its sewage and rainfall discharges combined, in one set of drains and sewers, to one outfall or pumping station, so that the drains and sewers may be maintained in a self-cleansing, and consequently sanitary condition, are physically insuperable, i. e. at a reasonably permissible cost. Equally insuperable would be the difficulties, if he had to drain such a town on the separate system, were the whole of the sewage conducted to one outfall or pumping station.

For scientific, sanitary, and economic reasons, the author has long advocated the adoption of the separate system, in preference to the combined system, in all new drainage projects, providing of course, that the works are carried out throughout, on sound sanitary principles, and providing the drainage of the sewage proper cannot be conducted, say to a sea outfall, through drains and sewers which will carry the sewage separately, or in combination with the rainfall, at a perfectly satisfactory self-cleansing velocity. But some of you may be disposed to say, what other engineers have said in effect before, viz. that all sanitary engineers now-a-days lay down sewers at gradients which will secure "self-cleansing" velocities. This we know they do, to the best of their abilities; but, we also know that many engineers call sewers designed by them self-cleansing sewers, if they are laid at gradients suitable to their size, regardless of the volume of sewage available to them. We have known engineers, for example, advise sanitary authorities to the effect that a 24-inch sewer laid at a gradient of 1 in 805, was laid at a self-cleansing gradient—which was literally true, if only the volume of sewage, estimated to be available to the sewer, had been sufficient to half fill it; but, inasmuch as the sewage available was barely sufficient to half fill a 6-inch pipe, laid at a gradient of 1 in 150, the velocity of that volume of sewage flowing on the invert of the 24-inch sewer, would not exceed 1·16 feet per second; giving only 46 per cent. efficiency, instead of 100 per cent.! In this case, as in many others, the engineer laid the sewer at the best inclination at which he was able to lay it, owing to the natural configuration of the ground! It is in this way that the so-called English water-carriage system of sewage removal from houses and towns has wrought so much unsanitary mischief, all the world over.

A 24-inch sewer is $\frac{24^2}{6^2} = 16$ times more capacious than a 6-inch pipe, and consequently, all things being equal, it will hold 16 times more foul air, and it will require 16 times more water, to flush it, than would be required to flush the 6-inch sewer. Moreover, the 24-inch sewer would cost roughly five times more than the 6-inch sewer! These statements tend to show that we ought in all cases reasonably possible, to recommend the adoption of the separate system of town drainage. Again, the cost of treating sewage conducted to the outfall on the separate system, is reduced to a minimum. The value of sewage discharged on the Shone system—where the separate system of drainage is adopted in connection with it—if it is utilised as liquid manure upon land suitable for irrigation purposes, must necessarily be much greater than it can be when it is discharged into drains and sewers on the combined system.

But it would be impossible for the author to explain his views fully on these matters, in the compass of a paper like this, without taking up much more of your time than he is entitled to do. He will, therefore, content himself by saying that the most important part of the work of a sanitary engineer is to drain houses of their sewage discharges in such a way as to cause the minimum unsanitary nuisance *en route* to the outfall. And the way to do this, as he has already stated, is to lay down all drains and sewers by hydraulic rule. If the hydraulic rule cannot be acted upon by trusting to natural gravitation drainage, then recourse should be had to artificial or mechanical means—such as can be obtained from the adoption of the Shone system.

The framed perspective drawing, which the author has brought with him to this meeting, will, he trusts, enable him to explain the system thoroughly, without his having to weary some of you who are already conversant with it, with somewhat elaborate descriptive details which are not essential to the proper understanding of the system. You will perceive from the drawing,* that a town or district, as flat as a pancake, can be subdivided into as many sections as may be necessary to ensure, (1) The *essential* gradients being always obtained for the smallest permissible pipe sewers; and (2) to avoid deep and costly trenching for the gravitation sewers and ejector stations. By adopting this plan of drainage, *small bore pipes of short lengths only* are required, and these, at the lowest points, viz. at the ejector stations, need not exceed 14 feet on the average, in depth. In this way a flat surface built over, and containing about 40 acres, could be absolutely *sanitarily drained* by one ejector station. If this area were inhabited, at the rate of 50 persons per acre, then the sewage of a population of (40 × 50) = 2000 would flow to the ejector station. Again, if this population discharged sewage and rainfall combined, into the sewers, equal to 30 gallons per head per day, then, according to the author's rule of determining the maximum quantity of sewage, which would have to be ejected, at such a station, the volume would be equal to $\left(\frac{2000 \times 30 \div 2}{400}\right) = 75$ gallons per minute. For this quantity we should specify two ejectors, each of 100 gallons capacity. The ejectors and station complete, would cost about 450*l.* If the lift, and friction combined, equalled say 60 feet, then 75 gallons per minute of compressed air, at a pressure of (60 × ·434) = 26 lbs. per square inch, above the atmosphere, must be supplied to the ejectors to work them. This would require an engine to *indicate* $\left(\frac{75 \times 60 \times 10}{33{,}000 \times \cdot 40}\right) = 3 \cdot 4$ horse-power. If this station were one out of many, then the coal consumption would not exceed 3 lbs. per indicated horse-power per hour; and for 14 hours' working, this would mean a coal consumption of $\left(\frac{3 \cdot 4 \times 3 \times 1}{112}\right) = 1\tfrac{3}{10}$ cwt. per day, which would cost, at 20*s.* per ton, 1*s.* 4*d.* per day. The cost of attendance at such a station would be inappreciable. Indeed the cost that would be necessary to incur for attending to purely gravitation drainage works, would not be exceeded by the cost that the ejector attendance would involve.

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* See p. 221.

The following towns have applied the Shone system, more or less, in *its entirety,* viz. Henley-on-Thames and Beaumaris (at these places automatic flush tanks, and the author's new system of ventilating sewers, were not used), Rangoon, Hampton Wick, and Wallingford. The improved system of ventilating sewers was not applied at Rangoon, for the reason that it was not invented at the time when those works were designed. But at Wallingford is to be found the most complete example of drainage works on the Shone system. There the public sewers have automatic flush tanks and air inlets at their heads, and there also all the manhole covers are sealed, and the nozzle sewer ventilators are connected with each ejector station.

You all know that complaints of sewage-gas nuisances arising from perforated manhole covers over street sewers, are all but ubiquitous, and these nuisances are intensified when house connections are being formed with new drainage works. At Wallingford, however, such nuisances have been rendered non-existent; not a single case of complaint having been made up to the present time.

The author would have been sincerely glad if this meeting had been held at Wallingford, so that you could judge for yourselves of the correctness or otherwise of a statement that has recently been made with respect to that town, and which is to the effect that it is the best drained town in the world at the present moment. He hopes, however, that those of you who are earnest sanitarians will take an early opportunity of visiting Wallingford.

We cannot enter, in this short paper, into a description of works carried out at Eastbourne and other towns on the system; but there are at the present time encouraging signs visible to the author, to show that it is gradually but surely making headway. For instance, the forthcoming great Chicago Exhibition is to be drained on that system, and the sanitary authorities of the following sea-side resorts, taking their cue from beautiful and successful Eastbourne, have adopted it, viz. Llanfairfechan, Hastings (for a part of the town), and Felixstowe.

But occasionally objections are raised to the system on the score of first cost. The following statement, which may be relied upon, will, however, serve to show that even in point of first cost, the Shone system is to be preferred to the ordinary gravitation drainage. For example, the following towns were drained on the ordinary system, viz.: Margate (where hydraulic pumping is resorted to), Southport, and Llandudno, and the cost per head amounted to 4*l.* 7*s.*, 6*l.*, and 7*l.* respectively; or an average of 5*l.* 15*s.* 8*d.* At the following places, drained on the Shone system, the approximate cost per head has been as follows:—

	Cost per head.		
	£	*s.*	*d.*
Beaumaris	3	0	0
Henley-on-Thames	3	15	0
Wallingford	3	9	0
Hampton Wick	3	7	6
Average	3	7	10
Rangoon	2	2	4

The chief object in view in giving you these costs is to show your Association that *high-class* sanitary drainage works, on the Shone system, may be carried out at home and abroad, at fairly low prices per head of the population. In point of fact, the author knows cases where the ordinary gravitation plan has been carried out at prices which are more than double those at which the same extent of sewerage work could have been carried out on the Shone system.

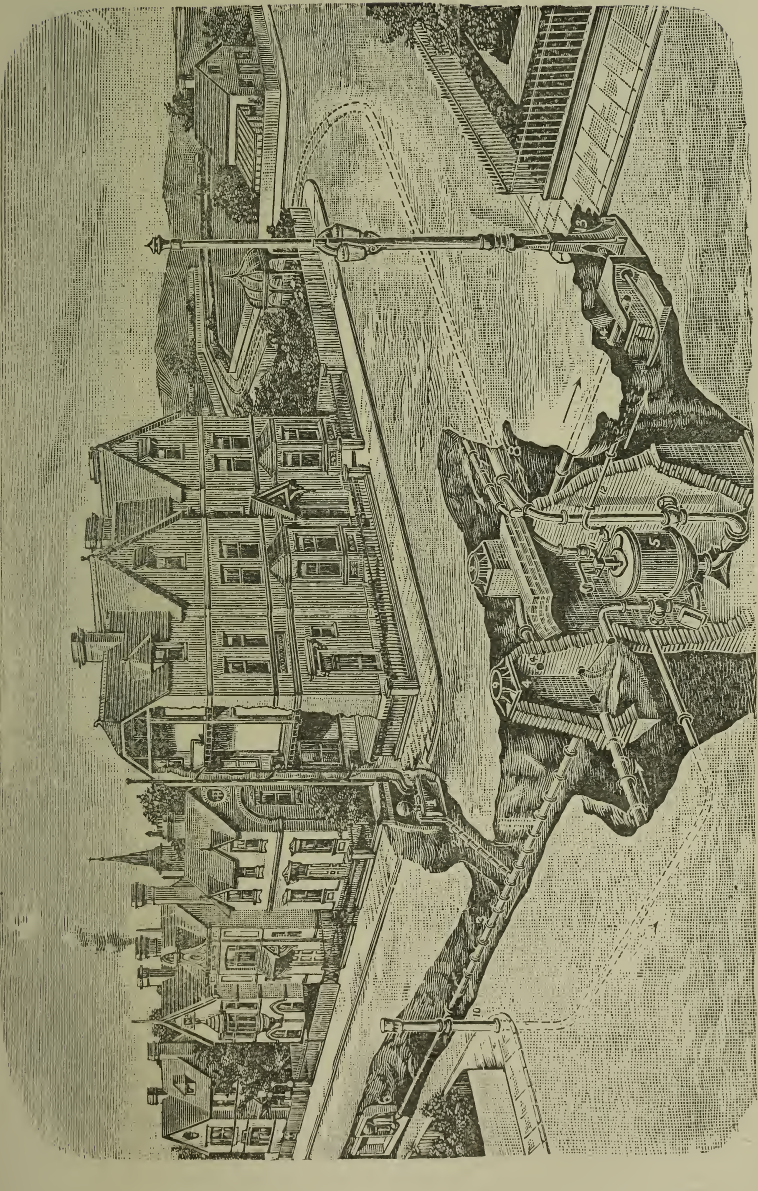
The engineer who carries out drainage works on the lines indicated above, will at all events have the satisfaction of knowing that the whole of his work has been carried out on sound engineering and sanitary principles; and, for these reasons, in their own and the public interest alike, the author hopes that the members of your Association will give the subject-matter of his paper their most careful attention.

APPENDIX.

For the benefit of absent Members of the Association, who had not the advantage of listening to the author's verbal explanations of the picture, or framed perspective drawing referred to, it has been thought advisable to add to the foregoing paper the following block drawing, and explanations. This block is not, however, a reproduction on a small scale of the pictorial drawing exhibited, neither are the explanations which accompany it, the same as those which were given verbally at the meeting. But it is hoped and believed that both the block and the explanation now given, will enable, not only the absent members of the Association, but all those who read the paper, to understand what the Shone system of town drainage really means, when it is adopted, in its entirety, or otherwise.

Explanations descriptive of the Pictorial Drawing, which is ideal only. (*See p.* 221.)

The various apparatus, structures and pipes, &c., required to operate the Shone system are shown in the drawing and figured consecutively from 1 to 14 inclusive. (1) Automatic hydraulic house sewage ejector, for utilising the domestic waste fluids of households, to flush the drains, instead of using exclusively potable water for the purpose. This apparatus, besides being a flush tank, is also a trap, as between the main drain of a house and the public sewer. But its use is only recommended in connection with the drainage of houses set back a long way from the sewers—as houses are set back, as a rule, in suburban areas, and where, too often, the gradients of the main drains of such houses are insufficient to cause the household wastes to



flow through them at self-cleansing velocities. This apparatus can, of course, be used in connection with ordinary gravitation sewerage works. (2) House drain (stoneware pipe). (3) Main gravitation sewer (stoneware pipe). (4) Manhole. (5) Hydro-pneumatic ejector. (6) Automatic public sewer flush tank. (7) Compressed air main. (8) Sewage delivery main (cast-iron). (9) Sealed manhole covers. (10) Iron air inlet pipes, carrying fresh air into the sewers, at their heads. (11) Automatic gear of the hydro-pneumatic ejector. (12) Iron exhaust air pipe. (13) Iron ventilating or exhaust air pipe or shaft, through which the air of the ejectors, compressed and otherwise, escapes into the atmosphere, combined with the fresh air drawn through the sewers, by vacuum power, created at the nozzle, which is fixed at the base of the ventilating pipe or shaft. (14) Pipe through which fresh air from the sewers is drawn (1) to the nozzle, and (2) up the ventilating pipe or shaft into the atmosphere again.

DISCUSSION.

Mr. E. Buckham: I should like to ask Mr. Walshaw whether every manhole used in connection with the drainage is fitted with sluices, so that it can be filled with water, and made use of as a flushing chamber. It may be that there are special flushing chambers, but if sluices were put in and every manhole made a flushing chamber, he would find it a useful and economical mode of flushing sewers. In carrying out the drainage of Peterborough I would also like to know if any subsoil water was met with in the construction of the sewers, and if so, how it was dealt with? Then just one question upon Mr. Gill's paper with regard to the waterworks. I should like to ask Mr. Gill if he tried any form of jointed pipes other than those referred to in his paper, and, if he did, whether he will be kind enough to give us the results of his experience. With regard to Mr. Shone's paper, first of all I should like to tender to him my sincere thanks for giving up so much valuable time at my request for our meeting to-day. When gentlemen come forward from outside our Association and give us the benefit of their experience I am sure every member is grateful to them for their assistance. Another reason why I asked Mr. Shone here to-day is because I feel the Shone system is particularly applicable to many towns and districts in the Eastern Counties, as it is a system peculiarly suited for low levels and flat districts, and it can be applied with more satisfactory results, so far as I can see from my investigations, than any other system of raising sewage. I had under consideration some time ago the adoption of a drainage system for Stoke, which is part of Ipswich on the west side of the river, containing a population of about 4000 people. For engineering purposes it is practically level. The main sewer line would be about 5000 feet in length, and the ground exactly the same level at one end as the other. The question arose with me, could I raise this sewage without erecting a separate pumping station. In arranging for the sewage of the town I had already a pumping station in the marsh district, and I thought if I could transmit this power to Stoke I might be able to lift the sewage without incurring the expense of setting up a separate pumping station. I found, after making extensive investigations in other towns which had used the Shone system, that I could apply it in this way, and the result of my enquiry was so satisfactory that I recommended the corporation of Ipswich to drain the Stoke district on that system. By adopting the Shone system I am able to pump sewage—because it is practically a pump, though it is of a form that cannot be got in any other system—without acquiring ground and building a station thereon. I am able to provide the pumping station underground, and raise the sewage of the Stoke district, and put it into the main sewers without a separate pumping establishment. Any system that can do this and will save the cost of a separate station must be a very valuable and useful system of drainage. I think an objection has been made by some engineers that the Shone ejectors are nothing more than pumps. It is quite true they are pumps; but they are also a good deal more than pumps. They require no special care, no special machinery has to be made for them, and they are automatic. The fact is whatever goes into the ejectors must come out. They require very little attention, and the cost of maintenance is very small. Some engineers urge that the transmission of air is an expensive mode of power. I admit the transmission of air for power is expensive, but if you can arrive at a certain result by the use of air you cannot get in any other way, then I say expense is a secondary consideration. I think the cost of transmission in the Shone system is more expensive than it would be in some other ways, yet I contend that the pneumatic system is the best. I felt I should like to say just a word or two on Mr. Shone's system as well as to thank him for coming here to-day, and I hope we shall have a good discussion on this paper, and that we shall be able to get some information which may be useful for the Eastern Counties.

Mr. C. F. **Gower** (Stoke): As the district of Stoke is one in which I live, and I take some interest in it, I should like to make some observations on the Shone system. As Mr. Shone properly observed in his paper, the advantages of the system are principally the transmitting of power from one pumping station to several other subordinate pumping stations, and the whole question is whether it transmits that power in the most economical way. We know that compressed air is not the most economical way of obtaining power; but, on the other hand, there is the convenience of having the pumping station under the street, and other advantages. At the same time I am not quite satisfied myself that the sewage of Stoke could not be dealt with as economically by other systems as by the Shone system. Mr. Shone has made some allusion to surface water and the separate system. In theory I greatly approve of separating the surface water, but in working it is a most difficult matter.

Mr. MacBrair: I notice that Mr. Walshaw says the rye grass from the farm is sold at 4*d.* per sack. Will he kindly put the sacks into cwts., so that we may work out the price obtained. He also says the farm cost the Corporation 132*l.* per acre. Is not that rather a high price? I should also like to ask a question as to the wood paving at Norwich. Mr. Walshaw states the system he has adopted is similar to that at Norwich—the wood being laid without concrete foundation at a cost of 5*s.* 6*d.* per yard, the paving giving great satisfaction. I have not had the pleasure of visiting Norwich, but several members of my Corporation have been there, and when the question of wood paving came up in my town a year or two ago, they refused to have that system adopted in Lincoln, as they were by no means satisfied with it. With reference to concrete pavement for footways, I notice Mr. Walshaw says "that made with slag is the most durable, but its slipperiness is objectionable and I have discontinued using it." In Lincoln I am using at present granite sand, and slag dust, having tried nearly every kind of material, and find they make a less slippery pavement than any other materials. Mr. Walshaw says that horse, cart, and man are hired for 6*s.* 6*d.* per day. I thought about 8*s.* or 9*s.* a day was the usual price. Mr. Walshaw also refers to the building bye-laws, and says that two years ago the model building bye-laws were adopted. Might I ask upon that whether they insist in Peterborough upon plans for wooden buildings being sent in. We continually find persons putting up wooden buildings on the space of 200 feet reserved at the rear of dwellings, and thus the 200 feet are sometimes reduced to 150 or 100 feet. Mr. Walshaw says, the average death rate of the borough for the past ten years has been 14·7; for the previous eight years the average was 24·7. That is an effect and a great one. Might I ask him to mention any specific cause? Is the connection of the houses with the main sewers the chief one, or what? With reference to public lighting, Mr. Walshaw says the cost is 15*s.* per lamp per annum. My experience shows that that is rather a low figure. Will he tell us the number of hours he gets the lamps lighted per annum for that sum?

Mr. Silcock: I beg to propose a vote of thanks to the authors for their papers. We are much obliged to the gentlemen who have taken the trouble to prepare these papers, and I am sure the members of the Association will accord them their hearty thanks. I can say from personal observation that the streets of Peterborough have been very greatly improved during the last few years. The improvement is most marked, and I consider Mr. Walshaw has made Peterborough one of the best paved towns I know anywhere in the county. With regard to the death rate, there is no doubt that the figure of 14·7 per thousand is a very excellent result, and must be due to the fact that the corporation were so wise as to go in for good water supply and drainage system simultaneously. I should be glad to know if any member of the Association has yet framed any bye-laws under the Public Health Amendment Act of 1890. It gives us very greatly increased powers, and it would be very useful to gather information of what is being done in various towns. I gather from the paper that Mr. Walshaw has not done so. (Mr. Walshaw: No.) With regard to the water supply, the system adopted seems to me to be a very good one, and the water obtained very pure. The only thing that strikes one is the very large cost at which the supply has been obtained. The works appear to be very efficient but very expensive. For instance, the engines, pumps, and boilers cost 9000*l.* We are not told at what steam-pressure they are working, but I should say that with direct-acting engines working up to 120 lbs. steam-pressure triple expansion, the work would be done quite as economically as at present, and the first cost of such engines would be about half the money named above. Then the service reservoir cost 7356*l.* Unless there are some special circumstances, such as heavy cartage, to account for that, it appears a very large cost to incur for a brick reservoir of that size. Between 4000*l.* and 5000*l.* is a fair price for such a reservoir.

Mr. R. Godfrey: I second the vote of thanks with very great cordiality. The papers read to-day are of very great interest to every member of the Association. I am not going to criticise them except upon one point raised by Mr. Walshaw. It is a point I feel rather strongly upon. I refer to the complaints of sewer-gas rising from manholes in the streets. We are largely indebted to the Local Government Board and to Parliament for the sewer stinks we have in the roads. It is not the fault of the surveyor or of the local authority. If we had the right to carry every sewer to its logical termination we should have no need for street ventilators or elaborate nozzles such as those of Mr. Shone. Every house contributes to the sewage in the sewer, and every house should contribute to the ventilation of the sewer. Where, as at present, every house has to be disconnected from the sewer, and while they contribute to the filth, they do not assist in the ventilation of the sewer. If every house had a ventilating shaft carried up to a safe point there would be no need of artificial means of ventilation. I hope to see the time arrive when the local authority will have power to compel every householder to ventilate his own house drains, and the local authority have power to place a ventilating shaft up a man's premises, even against his will, by payment of way-leave. We can take a sewer across a man's land, and why should we not have the same power to put ventilating shafts up the sides of the houses? In an undulating town the shafts on the low levels would act as fresh air inlets and on the high levels as foul air outlets. I have always found that the only way to avoid smells is to increase the openings, and the best way to increase the openings is to place them out of the reach of people's noses and the sight of their eyes. I was told the other day by the City Engineer of Bombay that some time ago he put a ventilating shaft up a house but had never connected it. The gentleman who lived in the house having seen the shaft there, thought there must be a smell and applied for an injunction. When the case came on the engineer requested the judge to defer his decision for six hours so that the ground might be opened. This was done, the ground opened, and it was proved that that shaft had never been connected with the sewer, showing the fallacy of the objection, and I have had similar cases to this in my own district. On this question of sewer ventilation I feel we must come to first principles. All these artificial modes of ventilation, whether gaslight or nozzle, will end in failure; and in the end every house will have to contribute to the ventilation as every house contributes to the filling of the sewer.

Mr. Barber: Perhaps Mr. Walshaw will kindly describe to us the wood paving in Norwich which he says has given complete satisfaction there. I do not know what that system is; at all events it would be interesting to have it explained to us. I may simply say that some of the wood paving here would not be satisfactory in many other places. It would not do in the suburbs of London, where we have to lay a foundation with six inches of the best Portland cement concrete, and pave thereon with 6-inch blocks. It would be interesting to know how this is done, which has proved so satisfactory at Norwich.

Colonel Jones, V.C.: I can only repeat what has been said by other speakers as to the great pleasure it has given me to hear these papers read to-day. Having been connected with the Shone system from its very infancy I am naturally pleased to see the issue put forward so clearly and simply, and above all I am pleased by the practical remarks of Mr. Buckham who appears to have thoroughly mastered the intricacies of the system. Its advantages and adaptability to many localities have at length made their way among engineers. The adoption in Berlin of the radial system by which the sewage of Berlin is collected in various districts and pumped in various directions is clearly a recognition of the first principle of the Shone system, which was the first to demonstrate the possibility of concentrating sewage by gravitation to one point in each section of the area to be sewered, and then lifting it. The Shone system must be an immense advantage in waterlogged districts. There is another thing regarding the paper on Peterborough. That is making the sewage farm the site of the small-pox hospital. This idea seems to show the possibility of converting the old mansions often found on estates taken up for sewage farms into convalescent hospitals, as has been done extensively on the Berlin sewage farms.

Mr. O. Deacon Clark: I was for sixteen years the municipal engineer for Rangoon. We had there a population which is rising very rapidly. When the works were designed we had a population of 150,000; that population has since gone up to 180,000; so we had to make great provision for the anticipated increase in population, and I think no other system would have met that increase so economically as the Shone system. One gentleman who has taken part in the discussion made a remark as to the expense of lifting sewage by pumps as compared with compressed air. I may say I saw the Eastbourne works before I recommended the system to the municipality of Rangoon, and thoroughly satisfied myself about the system. When I was at Eastbourne the other day, a question was put as to what the cost of pumping had been, and if I remember rightly it was said to be about the price of pumping water. I suppose a 1*d.* per thousand gallons—it would not exceed that. I do not think you can pump sewage more economically than that, which is the cost at Eastbourne for the last twelve months. As regards the utility of the system, I think the Shone is far superior to the ordinary gravitating system. At Rangoon, where we have 32 ejectors, our outlet is about 3 miles away. Our tidal waters there rise 20 feet. We deliver the sewage 3 feet below the lowest tide and 23 feet below high water. Unless we had adopted the Shone system we should have been put to very great expense for pumping.

Mr. WALSHAW, in reply, said: The whole of the manholes are not so constructed as to admit sluices, wooden disks with india-rubber rings are mostly used. Subsoil water finds its way into our sewers in large quantities, Stanford's pipes were used, but here, as I believe in other places, they have not kept the water out. The flow of sewage has never been tested, but it amounts to about 750,000 gallons a day. The rye grass sent from the farm realises about 10*s.* per one horse load. The price of the farm was 132*l.* per acre. That amount was awarded by arbitration. We thought at the time it was a considerable sum, but as it was awarded by arbitration, we had to pay. Wood paving has only been tried on a very limited scale, and my remarks on paving only apply to a limited area in Peterborough. We had a very good sand bottom on which to lay the wood blocks, 9 inches by 3 inches by 5 inches deep. Then with respect to the concrete footpaths, we used a slag dust as a top coating. We found that to be so slippery that it had to be indented with a chisel. A horse, cart, and man we get from 6*s.* 6*d.* a day. It is a very low figure, but we are in an agricultural district. With respect to wooden buildings, we are not much troubled with such erections on yards at the rear of houses. Some wooden buildings are erected on gardens, but we carry out our bye-laws very stringently. Then with respect to the reduction of the death rate I consider that to be entirely due to our new sanitary works. Prior to the carrying out of those works, typhoid fever was very prevalent, and in one year there were upwards of 600 cases dealt with at the public dispensary, and now the disease is almost unknown. As to public lighting, those gas-lamps which are lighted all the year round cost 3*l.* 7*s.* 10*d.*, those lighted part of the year cost 1*l.* 16*s.* per annum; the 15*s.* given in the paper is the cost of cleaning, lighting, and maintaining the lamps, and does not include the gas. With respect to the ventilation of the sewers that is a most troublesome matter. When Peterborough was re-drained, all our house drains were "disconnected" from the sewers by means of syphons. They were a great objection, as they silted up in a few months, and now they are all removed. We "disconnect" every water-closet and cause it to be ventilated. We use a pipe of not less diameter than four inches for ventilation. There is another question, and that is with respect to the ventilators used. I contend they ought not be of ordinary cast iron, because they so soon choke with rust, but that the use of galvanised iron ought to be compulsory. Then with respect to roads, we put down two short lengths of tar macadam, one of granite, and one of slag. The tar macadam made with granite crumbled up, but that made with slag is still in good order, having been down for two years. The wet weather coming on directly after that made with granite was laid, may have been the cause of disintegration.

Mr. J. C. Gill, in reply, said: I think the first question I was asked was whether I had tried any other means of joining iron pipes. I have not for large mains tried any other joints than either bored and turned or lead joints; in the latter case I have used red lead instead of yarn for caulking. We have laid 4000 tons of pipes with bored and turned joints, and they have been in work thirteen years with most satisfactory results. Mr. McBrair asked if the 22 gallons of water used per head all went to the sewage farm. It does not. Mr. Silcock was good enough to compliment the corporation for going in for a good water supply. I think when you find the corporation of a town like Peterborough going in for an expenditure of 200,000*l.* for a water supply and sanitary works, they are deserving of credit for public spirit; Mr. Silcock has also referred to the cost of the engines, boilers, and pumps. If he had gone over to the waterworks and had seen them, he would not think the cost excessive. Mr. Silcock, with the knowledge he possesses, knows that you can get engines at any prices, but these are well worth the money. With regard to the cost of the reservoir I admit it is high, but if you saw the position in which it is placed you would not consider the cost excessive. The reservoir is miles away from everywhere, and the cartage was tremendously heavy, which accounts for the cost. The water scheme has worked satisfactorily, and it is not, taken altogether, an expensive scheme. The cost of maintenance since the works were started fourteen years ago has been low, and the town is well supplied with water at moderate cost. Mr. Silcock asks how the sealing of the tubes into the water rock is accomplished. To make an absolutely water-tight joint between the bottom of the tube and the rock into which it is fixed was a matter of some difficulty, but by repeated trials was in each case effected. The method adopted was to carefully ream the hole in the rock, and then to fit the tube with a conical plug, composed of rings of sheet lead, cut to sizes to fit the reamed hole. The plug was forced down into the hole prepared for it, and after withdrawing two or three times, and carefully examining it to see what alterations were required, either to the plug or to the hole, a good and water-tight seal was secured.

Mr. Shone, in reply, said: Something has been said in the course of the discussion about compressed air being costly for the transmission of power. As a matter of fact, it is extremely economical. You know you can transmit water comparatively long distances very economically, and as air is 820 times less in weight than water, it follows that the power required for transmitting air must be 820 times less than for water, at the same velocity. Recently Professor Unwin made the following statements in writing on the subjects of power transmission by compressed air and water. "Mr. Shone has adopted compressed air for distributing power, and there are good reasons for the choice. Compressed air has long been used for transmitting power for intermittent work in mining, and recently for distributing power in towns. All the details of an air transmission are simple, the mechanism is well understood. For a hydraulic transmission an excessive pressure must be used; in fact, usually the pressure in hydraulic transmission is 750 lbs. per square inch. But with air, more power can be transmitted through a 6-inch main with 45 lbs. air pressure than with 750 lbs. water pressure. That is because with air a velocity 20 times greater than that permitted with water can be allowed without incurring any practically appreciable loss in friction in transmission. With air the quantity used adjusts itself to the work to be done, in consequence of the expansion of the air. But with water the quantity used depends only on the size of the motor cylinder and is always the same whether the resistance is great or little. From the low pressure at which air can be used, an extremely simple form of pumping arrangement can be adopted, with small and simple working parts, little liable to get out of order and requiring very little attention or repair." I can tell you, gentlemen, that this compressed air system, as I apply it, is really economical. Messrs. Hughes and Lancaster went to considerable expense at their works to set that question at rest. They engaged Professor Unwin to test the working of the ejectors now in use at Lowestoft. The air compressor employed for the purposes of the test was one of Atkinson's 6 horse-power cycle gas engine air compressors. The sewage was lifted to a height of 25 feet, and an efficiency equal practically to 50 per cent. was obtained. I will undertake to say I will guarantee this satisfactory efficiency with the ejectors situated a mile away from the air-compressing station. I am speaking to you as practical men, and you may take it as absolutely true that this efficiency can be obtained; and if so I ask you to show me any pump that will lift rough unscreened sewage 25 feet high automatically, and at the same time for the pump to give the same degree of efficiency as the ejector. I believe there is a complete misconception in the minds of many surveyors and engineers as to the efficiency of pumps, especially for pumping sewage. I would challenge any of you to name a single installation where a sewage pump is to be found giving a higher efficiency than 50 per cent. for a similar lift. Now with regard to the separate system, I do not want you to look upon me as a theorist. I have carried out works on the separate as well as on the combined system. I always separate as much rainfall as possible from the sewage, but I do not go to the extent of excluding from the sewage sewers all the rain that falls on roofs and backyards. In every case where I have adopted the separate system I have made calculations providing for taking rainfall from a limited roof, &c., area, and the works I have carried out have never given any trouble at all. In many towns, the original sewers are old and in a bad state, and when you are dispensing with the old state of things and instituting new works, these should be carried out on strictly sound sanitary engineering principles. I want you above all things to insist on having efficient sewers. At Eastbourne they are now spending 25,000*l.* to separate as much as possible of the rainfall from the sewage sewers. That is the best illustration I can give you of the value of separating the rainfall from the sewage at the initial stage of all new drainage and sewerage works. Just one word about ventilation. Mr. Godfrey said he did not believe in mechanical ventilation, and thought all such systems would sooner or later result in failure. That is a very sweeping assertion. At one time natural ventilation alone was resorted to, to ventilate mines; but when the science of the subject was understood, engineers resorted to mechanical means, without which our modern mines would be unworkable. I admit the question of ventilating sewers is a difficult one; but I maintain you cannot ventilate sewers effectively unless you resort to artificial or mechanical means. If you adopt a system of perpendicular pipes terminated in the atmosphere above the roofs of the houses, in the manner recommended by Mr. Godfrey, you will find for weeks together the atmosphere is in a state of quiescence, and there is no motion whatever in the pipes, and under such conditions dangerous and foul gases will accumulate. You must have either heat or mechanical power to cause air to circulate in sewers as well as mines, and I respectfully submit that the artificial method designed by me, and which is described in the appendix to my paper, is not only scientific, but it must be efficient wherever it is properly applied.

CORRESPONDENCE.

Mr. **Kemp** writes: In the first place I should like to ask Mr. Shone if it has been ascertained what distance away his ventilating apparatus affects the air in the sewers. Of course in asking this I can quite understand that it will vary according to the pressure to which the air is compressed.

In reply to Mr. Kemp's questions, Mr. Shone says: I have not yet resorted to any elaborate tests to ascertain the exact way in which the air in the sewers is affected by the action of the nozzle; but I have had some practical tests made with a view to measure the vacuum power of the nozzles, as they have been made for Wallingford, and as far as those tests went they were satisfactory. The essential thing to do is to regulate the velocity of the air to be drawn from the sewers, and which can always be done, so that the air pressure required to cause the sewer air to flow shall not exceed, at most, an inch of water head; otherwise, the water traps disconnecting the air of the public sewers from the air of house drains might be untrapped or unsyphoned.

The air of the sewers need not travel at a higher velocity than the sewage, but if it travelled at double the velocity of the sewage, or say 5 or 6 feet per second, intermittently, i. e. during the time when the ejectors are exhausting the charges of compressed air, and the vacuum is then at its maximum power, the water gauge, even though the air was drawn through a 6-inch sewer a mile long, would not exceed 1 inch at the house drain trap nearest the nozzle. But when sectional drainage on my system is resorted to, it very rarely happens that the longest sewer, discharging into the ejectors exceeds half a mile in length.

The actual horse-power necessary to expend in order to move atmospheric air in a 6-inch pipe 1 mile long at a velocity of 5 feet per second, would be about the one-hundredth part of one horse-power; and air thus drawn from 20 separated sewers, each 1 mile in length, would not require more than about the $\frac{1}{5}$th of a horse-power.

That is to say an engine of $\frac{1}{5}$th of a horse-power nominal, or an engine giving an efficiency of say 25 per cent., would indicate $\frac{8}{10}$ths of a horse-power only to do the work.

These calculations are made for the *purpose* of drawing the attention of the members of your Association to the fact that very little power is required to ventilate small sewers of comparatively long lengths, laid on the Shone system. But in connection with this method of ventilating sewers, I utilise the power of the exhaust compressed air of the ejectors, which would otherwise be wasted, to do the work, and therefore the annual cost of operating this system of ventilation is absolutely nil.

The members attending the meeting having lunched together at the Angel Hotel, a few of the party visited the sewage farm, the remainder paying a visit to the Cathedral. The sewage farm consists of about 300 *acres of peaty soil, and grass, potatoes, beans, willows, rye grass, wheat, marigolds, &c., are cultivated with success. The whole of the sewage reaches the farm by gravitation. One portion of the sewage is brought at a sufficiently high level to pass into the settling tanks direct; the other portion, from the Huntingdonshire part of the city, has to be lifted about* 20 *feet by means of two sets of pumps. The sewage is taken round the farm by means of open conduits, and sluices are provided at intervals: and the clearness of the effluent water shows the sewage to be effectively treated. A small-pox hospital is situate on the farm, but it has only been found necessary to use it on five occasions.*

DISTRICT MEETING AT SCARBOROUGH.

June 18th, 1892.

Held in the Council Chamber, Scarborough.

T. De Courcy Meade, President, *in the Chair.*

The Ex-Mayor (Mr. Councillor Darley), who presided at the opening of the meeting, said: On behalf of the Mayor I beg to tender to you a most cordial welcome to Scarborough, and to express a hope that you will see much to admire and much to enjoy during your visit to the "queen of watering places." You have a short time even to see Scarborough, but you have also the business of your Association to transact, and papers to read and discuss from the Borough Surveyor and the Water Engineer. I hope, however, you will be able to see the process of asphalting carried out by the Borough Surveyor, and also to pay a visit to the Scarborough Floorcloth Works, after which I shall be pleased to meet you at luncheon at the *Bull* Hotel. I venture to hope the afternoon will be fine, so that you will be able to see Scarborough under fairly favourable auspices. I again welcome you on behalf of the Mayor, and as you have your business to transact I will ask your President to take the chair.

On the motion of Mr. J. T. Eayrs, seconded by Mr. Baker, Mr. J. Howcroft was unanimously re-elected as Honorary Secretary for the Northern Counties District.

The following papers were then read and discussed.

SCARBOROUGH, ITS PROGRESS AND ITS PUBLIC WORKS IN RECENT YEARS.

By JOSEPH PETCH, Borough Surveyor.

In preparing this paper, the author desires to intimate that an account of all the works of improvement designed and executed by him during the 22 years he has held the office of Borough Surveyor would be too much to attempt to describe in detail at the first visit of this Association, therefore the works more particularly mentioned in detail have been executed during the past 10 years.

Antiquity of the Borough.

Scarborough is a borough by prescription, a royal borough and a free borough. It was incorporated A.D. 1100, by a Charter from King Henry I.; this Charter is not in the possession of the Corporation, but reference is made to it in the Charter granted in the reign of Henry II., A.D. 1181.

There have been several Charters granted from time to time, and by a Charter granted in 1382 by King Richard II. the Borough was henceforth to be deemed a County in itself, distinct from the rest of Yorkshire.

King Richard III. granted a Charter in 1485, by which the Town of Scarborough and the Manor of Falsgrave (within the borough) "should be one entire County of itself incorporated distinct and separate from the County of York, and ever to be esteemed and named the County of the Town of Scarborough."

This King is said to have taken up his temporary abode at Scarborough, and that the house which he occupied still remains on the Sandside opposite the harbour.

Scarborough derives its name from Scar, a cliff, and Burgh, a castle, "The Castle Cliff" or "the Cliff with the Castle." It is situate at the end of a valley, and is built between 100 and 200 feet above Ordnance Datum, in a recess of a bay midway between Flamborough Head and Whitby, and is one of the terminal stations of the York and Scarborough, Hull and Scarborough, and Scarborough and Whitby branches of the North Eastern Railway. It is mainly dependent upon its visitors, in the season, for its trade. The fisheries give employment to a number of its population, and there is a patent tiled floorcloth manufactory in the borough.

The Corporation have ever been mindful of the fact that in order to keep pace with other health resorts and watering places on the North-east and South Coasts, it must necessarily follow a progressive policy, and in order to keep Scarborough to the fore and put the town into a thorough sanitary condition and make the place attractive, they have borrowed large sums of money at different periods and expended them on sewerage works, and various useful and important public improvements.

During the past 10 years there have been seven Local Government Inquiries for various works, and the amount sanctioned during that period was 81,400*l.*

The following are some of the main items of capital expenditure, the works for which have been designed and carried out by the author: Sewerage works 20,800*l.*, carriage drive and sea wall on the South Foreshore 4500*l.*, works of paving 20,500*l.*, improving highways 30,800*l.*, public walks and pleasure grounds 6000*l.*

Sewerage Works.

The town is divided into two drainage areas, with two main outfalls, following the natural valley lines of the district. The outfall on the south side commences near the Aquarium with a circular brick sewer 3 feet 2 inches diameter, continuing along the Foreshore Road to the West Pier, from this point to its outlet is 4 feet diameter, passing through the harbour and the outer pier with cast-iron pipes.

The gradient varies from 1 in 300 to 1 in 500, and was constructed by my predecessors at different periods from 1863 to 1867.

This outfall takes the subsidiary sewers in the Ramsdale Valley, the old part of the town, and the South Cliff, which in their turn receive the sewage of about 16,400 persons. The total length of this outfall is about 1250 yards.

The outfall on the north side of the town commences at High Peasholm and continues along the valley to the beach, where, until

1883, it continued across the sands and discharged at low water mark.

At this period the Corporation were considering a scheme for improving the north undercliff and foreshore, and the question of dealing with this outfall naturally presented itself, as part of the beach at this point would eventually be required as a bathing ground.

The author was therefore instructed to report upon this outfall. After careful consideration and taking observations as to the currents in the bay, he recommended that it be continued northward along the base of the cliffs, and discharge below low water mark into a creek of rocks at Scalbyness Point, a distance of about one mile beyond the Borough boundary. This recommendation was accepted and the works carried out under contract.

The new outfall was constructed of two half-brick rims in cement, with invert blocks and wrought-iron straps 6 feet to 7 feet apart, and where the crown of the sewer appeared above the level of the beach it was covered with cement concrete. It is 5 feet internal diameter, and continued through the rocks with cast-iron pipes for a distance of 200 yards; the gradient is 1 in 500. The total cost of this outfall, including 1850*l*. for the iron pipes, was 6900*l*.

The subsidiary sewers and drains discharging into this outfall are of various dimensions, some are brick sewers 3 feet diameter and others stoneware pipe sewers varying from 12 inches to 18 inches diameter. All the sewers have good falls and are carried out in straight lines, with manholes and lampholes in the usual way.

The population served by these sewers and outfall is about 17,400.

During the past 10 years about 3½ miles of brick and pipe sewers have been laid in various parts of the Borough. The system of ventilation adopted for the past 20 years is by cast-iron pipes varying from 4 to 6 inches diameter, carried up the gable ends of houses or other high buildings, clear of all windows and chimneys; all surface ventilating grids have been abolished. There are about 250 of these vent-pipes on the drains and sewers at the present time, and others are being added every year as the town extends. No difficulty is experienced in obtaining permission from owners to fix these vent-pipes on private property. They are all placed on sufferance, but it is a very rare occurrence that any person requests them to be removed.

STREET WORKS.

Most of the streets in Scarborough are now made up and repaired with tar paving. There are yet some streets, and the main thoroughfares into the town, which are made up and repaired with Whinstone. In some cases, tar macadam is substituted for dry macadam. The Whinstone is obtained from Inverkiething, Scotland, is hand broken, and costs 10*s.* 8½*d.* per ton in the yard when broken and screened.

The system of tar paving for footpaths has been adopted in this town for the past 30 years, and for roadways about 22 years, but it was not until 1883 that the Corporation decided to apply to the Local Government Board for sanction to borrow money for tar-paving works. The first application was made in November in that year, and the usual inquiry was held by Arnold Taylor, Esq., C.E., the inspector appointed, and a loan was sanctioned for 10 years. Several inquiries have since been held, and at the last inquiry held in 1891, by the late Thornhill Harrison, Esq., M.Inst.C.E., a careful examination of the paving was made by him, and in expressing himself highly satisfied with the system adopted said, "the secret of your success is that no water can get to the foundation."

The amount sanctioned to loan up to the present time for tar-paving works is 20,863*l.*, and instructions have been given for another application to be made for all the remaining secondary streets in the Borough.

The following is a description of the materials and the process of preparation ready for laying on the roadways. The first coating is composed of local stone, gathered from the beach along the coast and broken to a 2¼-inch gauge, placed in long heaps about 15 inches in thickness and about 5 feet in width; fires are kindled along the top of the macadam and the whole heap covered with clinkers and cinders, obtained from the gas works, and allowed to burn from 12 to 18 hours, according to the state of the weather. The heat strikes down into the macadam and evaporates all moisture. The whole of the materials, including the clinkers and cinders, is turned over in its heated state, and cold tar is incorporated while the material is still warm, and then deposited ready for use. The second coating is composed of screened gravel to a 1-inch gauge, and is prepared in a similar manner to the first coat, except that no clinkers are used, and the rough portion of the cinders used in burning are removed and re-used. The finishing coat is a mixture of fine cinders and gravel, the whole to pass through a $\frac{3}{8}$-inch mesh riddle. The cinders are laid on the ground about 6 inches thick, and 6 inches of fine gravel on the top. The whole is then covered with the rough cinders as before, and heated in a similar manner to the other materials. After burning about 48 hours, the materials are passed through a $\frac{3}{8}$-inch riddle to remove the rough cinders used in the heating process. The fine cinders and gravel being then mixed together, they are incorporated with cold tar and thrown up into heaps. The material for footpaths are prepared in the same manner as described for the second and finishing coats for the roadways. The footpath foundations are formed of brick rubbish or sandtone about 4 inches thick, great care being taken that no clay is allowed to come in contact with the materials.

Before laying down the tar paving the roadways are put into proper form and consolidated with a 10-ton steam road roller. The undercoat is then laid on and again rolled with the steam roller. The second coat is treated in a similar manner, and the finishing coat follows on and a 7-cwt. roller passed once over it; a sprinkling of burnt gravel is then thrown on and rolled in. The rolling is continued until the surface is sufficiently set to admit of being rolled with a 2-ton horse roller 2 feet 6 inches diameter. The traffic is allowed to pass over the road as soon as the last coat is laid on. This system of tar paving is easily repaired, is dry in a few minutes after a shower of rain, is not slippery except in frosty weather, and street cleansing and watering is reduced to a minimum; it is impervious to moisture and is practically noiseless.

For a few months after the pavement is laid down, and until it is sufficiently set, complaints are sometimes heard, principally from cabmen, of the heavy drag on vehicles running over it, but as the materials consolidate, the surface hardens and the cause of complaint is removed. For the purpose of determining to what extent it was desirable in this Borough to substitute tar paving for ordinary macadam, the author prepared a return showing the annual cost of maintenance of some of the streets macadamised, and comparing the same with tar paving over the same period of 10 years.

The following are some of the typical cases :—

	Tar paving, Annual Cost of Maintenance.	Macadam, Annual Cost of Maintenance.
St. Nicholas Street	2·5*d.* per yd. sup.	8·5*d.* per yd. sup.
Huntriss Row	·6*d.* do.	0·3*d.* do.
Esplanade Gardens	Nil.	2·1*d.* do.
Grove Terrace Back Road	·25*d.* per yd. sup.	2·5*d.* do.
Cromwell Terrace	Nil.	3·7*d.* do.

Some roads in the Borough have been laid with tar paving for a period of 17 years and have not cost more than 2*d.* per yard super. for repairs during that period. We find this kind of paving to be most suitable for all streets, except main thoroughfares, where the traffic is very heavy. It is greatly appreciated by the residents and the many visitors who from time to time visit our town.

The cost of the paving for roadways exclusive of any foundation is 2*s.* per yard super. and for footpaths 1*s.* per yard super.

Under the 150th Section of the Public Health Act, all private streets are made up with tar paving and kerbed with 12 inches by 6 inches and 12 inches by 4 inches tooled Yorkshire kerb. During the past 10 years plans and estimates have been prepared for making up about 60 streets, and in all cases the work has been executed by the Surveyor and his staff, and others are now in hand.

Royal Albert Drive and Sea Wall.

Those Members of the Association who are also Members of the Institute of Civil Engineers may have read a paper by Mr. Whately Eliot, M.Inst.C.E., who was engaged as resident engineer on the works which have up to the present been carried out in the North Bay. It is there recorded that "the Corporation instructed their Surveyor to prepare plans for the construction of a sea wall and road at the base of the cliff."

To show the position of the author in relation to the works carried out, it may briefly be stated as follows :—

In April 1882 the Corporation resolved to take into consideration the question of dealing with the undercliff, and construct a sea wall in the North Bay, and instructions were given to prepare plans for a complete scheme, not only dealing with the North Bay, but continuing round the Headland to the South Foreshore Road.

The scheme proposed was for a sea wall and marine drive commencing at Peasholm on the north side, and extending along the North Sands at sufficient distance from the cliff base to form a drive 60 feet wide, and a promenade, 30 feet, to a point known as Coffee Pot Rock, a distance of 1600 yards. From this point the wall to be continued round the foreshore seaward of the Castle Cliff, at sufficient distance between the base of the cliff and the inside of the drive to form a receptacle for *debris*. Round the Headland the drive would be 40 feet wide, and the promenade 20 feet wide to its junction with the East Pier, thus forming a connecting link with the South Foreshore Road, a total length of 1 mile 1320 yards.

This scheme, with sections of the proposed wall, were submitted to the late Sir John Coode for his opinion and report. In June 1883 the report was received approving this scheme. The following is an extract taken the Report: "There can be no question that the drive and promenade would add considerably to the attractions of Scarborough. The wall from Peasholm to the northern point of the Castle would not be subject to a heavy wave stroke; not so, however the length from the latter point to the East Pier, which would be very much exposed, more so, in fact, than any other structure erected for a similar purpose with which I am acquainted. There need, however, be no apprehension on this head, as the height of the wall (19 feet above high water of spring tides), coupled with the effect of its concave face, and the great mass of the work, would be sufficient to ensure its security. There can be no question that Mr. Petch exercised a wise discretion in proposing a concave profile for the wall, as it will throw back the sea more effectually than any other, thus providing a drier road, and at the same time minimise the stroke of the waves against the works." In the autumn of 1885 a large quantity of shingle appeared on the foreshore, and in anticipation of the wall being constructed, the author commenced relief works, and collected about 6300 cubic yards; this material was afterwards found to be of the greatest service in the work, as no shingle of any quantity has since appeared.

The works as carried out are part of the above scheme somewhat modified, the position of the wall being considerably nearer the base of the cliff, and are fully described in the paper referred to, and recorded in minutes of proceedings of the Institute of Civil Engineers, vol. cv., Sessions 1890–91, part iii. Since the work was completed the erosive action of the sea upon the shale at the

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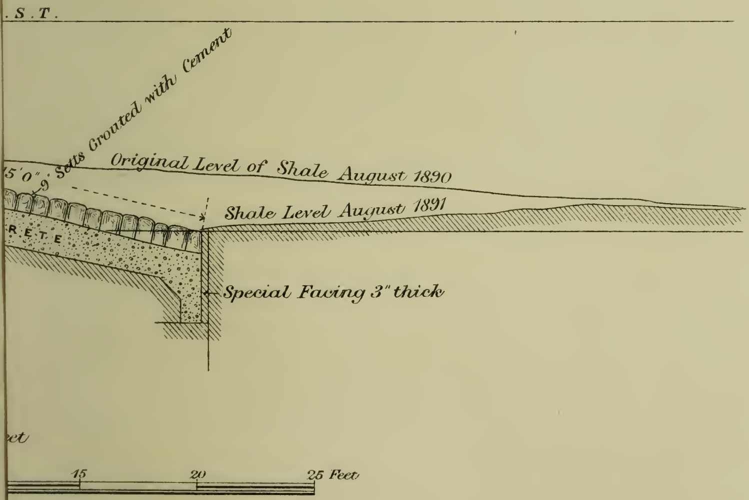

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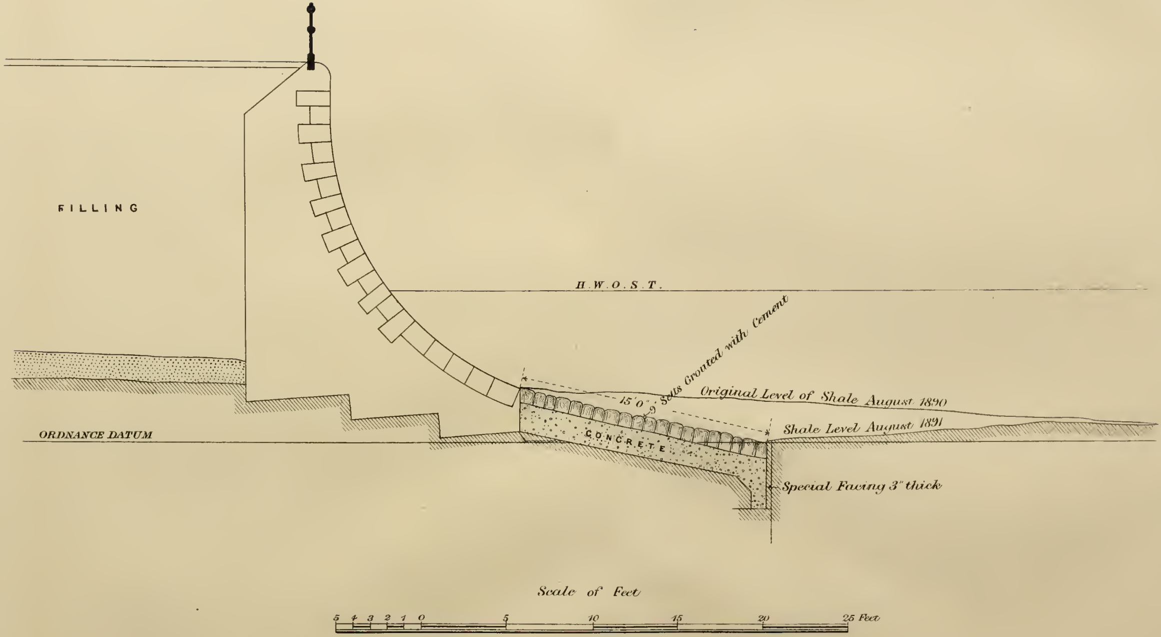
BOROUGH OF SCARBOROUGH.

ROYAL ALBERT DRIVE.

APRON TO SEA WALL



Thos Kell & Son, Lith.

toe of the wall would, if allowed to continue, have undermined the foundations. Within a period of 12 months it was found in some places to have scooped out to a depth of 3 feet into the shale. The author has since constructed an apron, which was formed by excavating out the shale to an average depth of 2 feet, forming a toe of concrete, and paving the surface with Yorkshire setts, 9 inches thick, and grouting with cement.

The toe of the apron, to a depth of 4 feet below the level of the shale, is formed of concrete with a special facing of one part of sharp sand to one of cement 3 inches thick, and was put in with the mass work.

The concrete in mass was composed of five parts of shingle, two of sand, and one of cement. The total length of the apron is 800 yards, and is 15 feet wide, with a fall of 1 in 4½ inches, and cost 2600*l.* It is anticipated that this work will prevent the further scouring away of the beach, and protect the wall for many years to come. It is the intention of the Corporation at some future date to continue the drive round the headland, and in anticipation of this work the necessary Parliamentary plans were prepared, and the scheme was embodied in an Improvement Act which was obtained in 1889. The Parliamentary estimate was 70,000*l.* In the event of these works becoming an accomplished fact, Scarborough would possess a marine drive about 2¼ miles in length.

The Clarence Gardens * in the undercliff are over 19 acres in extent; they are tastefully laid out and kept in good order. A band-stand and shelters have been erected, some of which have ladies' cloak-rooms and lavatories attached.

The cost of the North Cliff Improvement Works are as follows:—

	£
Purchase of land and law changes	7,139
Sea wall and Marine drive	27,000
Laying out and draining the undercliff	13,500
Construction of shelters and urinals	1,000
Total	£48,639

HOLBECK PLEASURE GROUNDS.*

These "Gardens by the Sea" are situate at the end of a ravine on the south side of the town close to the beach. In laying out these grounds a considerable quantity of water has been found in the cliff, and some heavy drainage works have been constructed at different periods during the past six years. The infiltration of surface water and atmospheric influences upon the upper strata of the cliff have caused heavy slips to occur at different periods. The method adopted to secure and protect the walks above the undercliff, and prevent the loose *debris* from going into the sea, was to put 6-inch drains with open socket-joints into the solid strata of clay underlying the loose and disintegrated earth, and filling up the trenches with rubble stone, after which benching into the solid strata and forming an abutment for a dry rubble screen on the face of the cliff. Where these works have been carried out the face of the cliff has been preserved.

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* The landscape work being carried out under the direction of local landscape gardeners.

Some of these works are now in progress, and other portions will have to be dealt with before the whole of the undercliff is made secure. The base of the scarf of the cliff is being protected from the encroachments of the sea by a pitch-faced stone wall which is now in course of construction; this wall is to be continued further southward to the boundary of the grounds. These grounds are 2½ acres in extent and well laid out, and although great expense has been incurred in order to maintain the gardens, and further trouble is anticipated, it is the intention of the Corporation to make these grounds secure and complete the laying out as speedily as possible. These gardens are highly appreciated by the visitors and residents, and have proved to be one of the best improvements carried out for some years. Shelters and urinals are provided similar to those in the Clarence Gardens.

The cost of the works, up to date, April 1892, are as follows:—

	£
Purchase of land	700
Draining and laying out	2760
Sea wall	1000
Shelters and urinals	640
Total	£5100

A number of other improvements of some importance, but which cannot be more than mentioned, have been executed during the past 10 years, namely:—

Widening, sewering, and improving the gradients of Seamer Road, at a cost of 2000*l.*

Widening, sewering, and improving the gradients of part of Filey Road, at a cost of 2000*l.* Plans have been prepared for the continuation of this improvement to the Borough boundary at an

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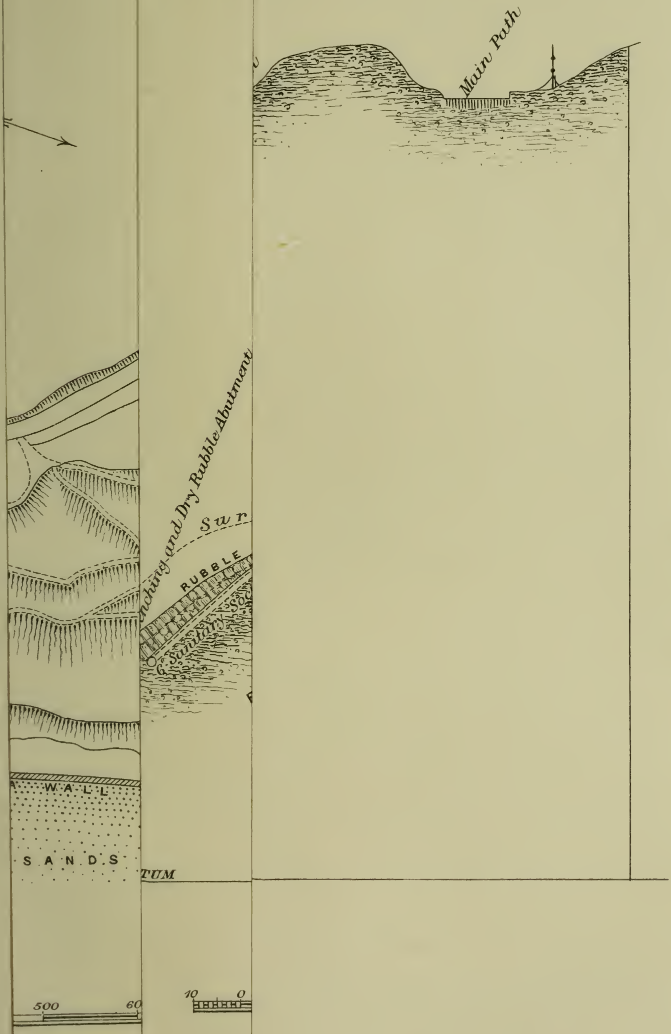

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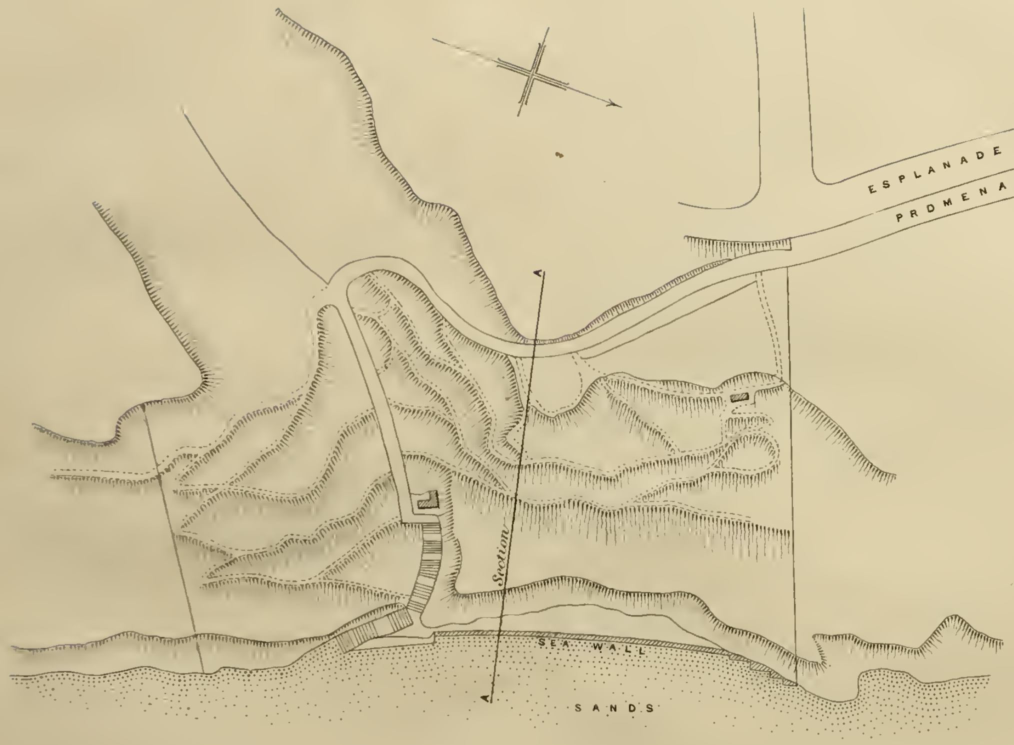
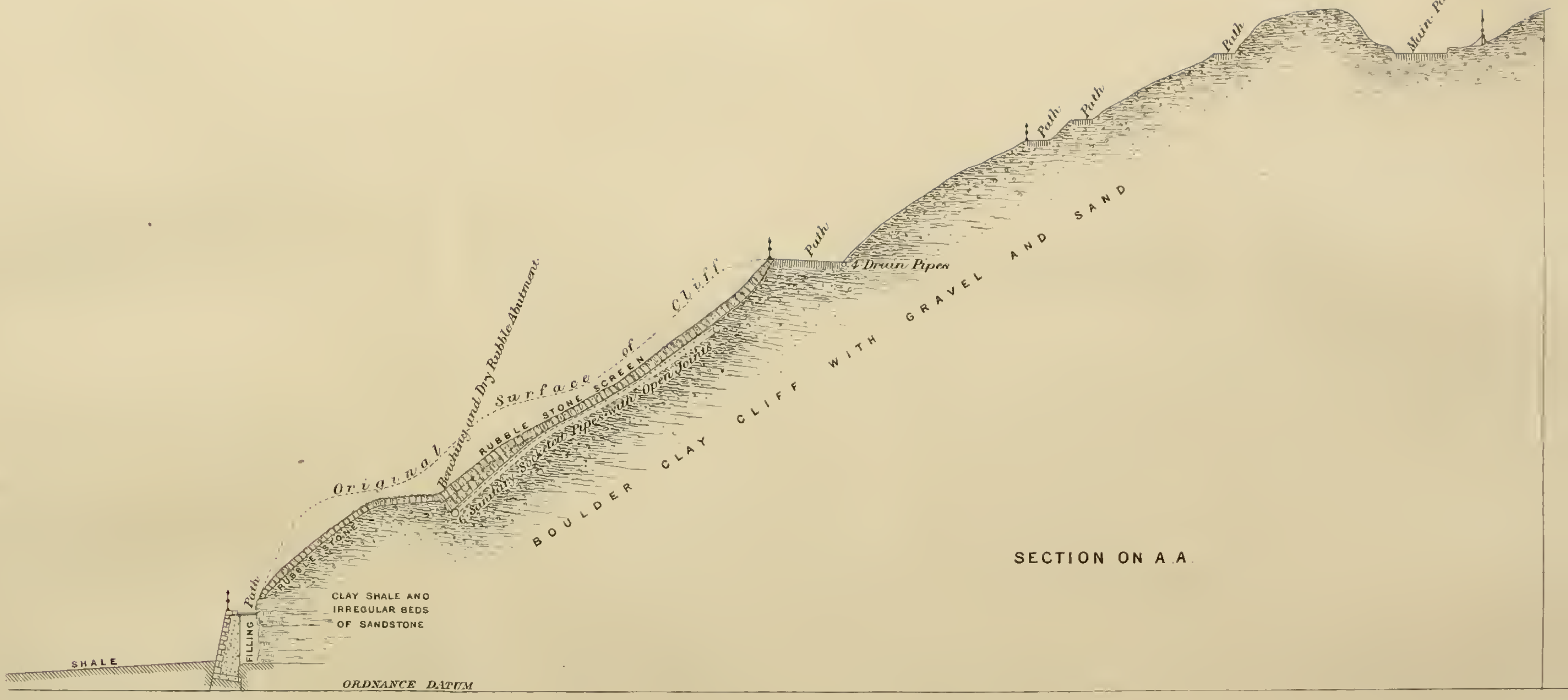
BOROUGH OF SCARBOROUGH.

HOLBECK PLEASURE GROUNDS.



PLAN


Main Path
Path
Path
Path
Path
4 Drain Pipes
BOULDER CLAY CLIFF WITH GRAVEL AND SAND
Original Surface of Cliff
Benching and Dry Rubble Abutment
RUBBLE STONE SCREEN
6 Sanitary Socket Pipes with Open Joints
RUBBLE STONE
Path
CLAY SHALE AND IRREGULAR BEDS OF SANDSTONE
FILLING
SHALE
ORDNANCE DATUM

SECTION ON A.A.

Scale of Feet
10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 Feet

Thos Kell & Son, Lith.

estimated cost of 3000*l*., but these works are at present in abeyance.

Widening and improving gradients of Falsgrave Road at a cost of 1500*l*.

Widening and improving the gradients of a portion of Stepney Road, including purchase of land, at a cost of 1950*l*.

Removal of the old bar in Westborough, and widening the main thoroughfare, including purchase of land, at a cost of 11,000*l*.

St. Nicholas Cliff, widening carriage-ways opposite the Grand Hotel, and forming new gardens, and fencing, at a cost of 1000*l*.

The author in concluding desires to acknowledge the valuable services rendered by his chief assistant Mr. George Ball, Graduate Member of this Association, in the preparation of this paper, and who has performed important duties in connection with the designs and execution of the works described herein.

STATISTICS.

The area of the Borough is 2,292 acres, and the Parliamentary and Municipal Boundaries are coextensive.

The following table shows the number of houses and the population in each of the census years from 1861 to 1891 inclusive:—

Census year.	Inhabited Houses.	Uninhabited Houses.	Houses.	Population.	Increase of population in each decade.
1861	3940	214	4154	18337	5422
1871	5161	561	5722	24081	5744
1881	6242	576	6718	30236	6155
1891	7236	797	8033	33777	3541

It is estimated that in the season the population is about 50,000. A census taken by the Corporation on the night of the 26th August 1882, of non-residents in the Borough, was 16,462.

1881.	Rateable value	£145,601
1891.	„ „	181,232

The death-rates for 10 years from 1881 to 1890 are as follows:—

1881	16·34 per 1000	1886	18·40 per 1000
1882	18·22 „	1887	16·64 „
1883	18 84 „	1888	15·66 „
1884	17·31 „	1889	17·40 „
1885	16 67 „	1890	16·40 „

The town is built between the low level of 25 feet and the high level of 200 feet above Ordnance Datum. There are about 35 miles of public highways in the Borough, of which about 5 miles have been declared main roads, and an arrangement has been made with the North Riding County Council for an annual payment of 1500*l.* towards the cost of maintenance.

The total rates in Scarborough, including poor rate, school board rate, burial board rates, &c., amounted last year to 5*s.* 6*d.* in the £. The general district rate is 3*s.* 2*d.* in the £; the same now as it was in 1887; in 1888 and 1889 this rate was 2*s.* 10*d.* in the £, and in 1890 3*s.* in the £.

DISCUSSION.

Mr. J. T. Eayrs: Unfortunately I have not had an opportunity of reading the paper before coming here to-day. I have had great pleasure in walking about Scarborough this morning, and seeing not only the front but the back streets of the town. It is well when you visit a strange place, not only to see what they can show you in the pleasantest parts, but to look behind at what are called the "slums." I see the method adopted in Scarborough of tar macadam makes the road impervious to water, and must be a great improvement in the back streets. Many of the houses I notice are without a proper system of drainage, and throw water and other slops into the street channels. Where the streets are impervious, as in Scarborough, this water runs to the street gullies, and thence into the sewers, and in a town on the sea coast there is no need of separating the storm water from the sewage, as the sewage generally discharges into the sea. I think we shall all learn something from the method of laying down these tar footways and roadways; in fact, I may say I have come down specially from the Midland Counties in order to see the work that is being carried on here, and that I might learn something so as to adopt a similar system for our inland towns. Of course the cost here, where I should say you would be able to get sufficient shingle from the sea beach free of cost, would be very much less than with us, as we are not able to get these materials for nothing. With regard to the sea wall and other works, I am afraid I am not able to touch on those matters, and will leave the discussion of them to other

Members. I am sure we are all much obliged to Mr. Petch for his kindness in preparing this valuable paper, and I would move a hearty vote of thanks to him.

Mr. Baker: I have very great pleasure in seconding the vote of thanks, and before I sit down I should like to ask one or two questions of the author of the paper. As regards the sewers, Mr. Petch says all the street ventilating grids have been abolished; I should like to know how many have been abolished. There can be no doubt it is a great benefit to get rid of them out of the streets. In my own town we never had any at all. We adopt the same plan of carrying a ventilating pipe up the houses and we never have any trouble or complaints from any of the householders so far as sewer gas is concerned. As to tar paving I notice that it seems to be all made of cold tar. That is a new thing, and I shall be very curious to see the process of mixing it. It must greatly depend upon the macadam being heated to a sufficient heat to allow the tar to become thoroughly incorporated with the material. I also notice that no pitch is used. Then Mr. Petch says, "We find this kind of paving to be most suitable for all streets, except main thoroughfares, where the traffic is very heavy." I should like to know what experience you have had with main thoroughfares, as it seems to me that that is rather a significant sentence. In a place where there is a narrow street, and a considerable amount of heavy traffic, such as traction engines, I should imagine it would soon cut up. I should also like to ask how often it is renewed. I notice here the cost in St. Nicholas Street is marked down at 8·5*d*. That is the annual cost, I imagine, and that St. Nicholas Street is one of your main streets where there is more traffic than elsewhere.

Mr. A. M. Fowler: We have had a very interesting paper from Mr. Petch. I know Scarborough well, and the visit brings back to my mind many pleasant recollections of the past. There is one important point in the matter of tarred macadam roads which I think is left out of the paper—that is the quality of the material with which the macadam surface is made. Of course the wearing of any road depends upon the nature of the stone of which it is composed, and the paper does not set forth whether it is limestone or granite, or what sort of material it is. If Mr. Petch would state the material it would be interesting among the answers to the discussion. In a place like Scarborough macadam is of great importance on account of the street gradients. In Newcastle I had a great many paved roads to take up and put down macadam. At

Buxton Mr. Hague has put down some excellent tarred macadam roads composed of the local stone. It is a great stride forward in sanitary work to have this tarred macadam, inasmuch as it keeps down the dust to a minimum, and keeps the water out of the foundations of the roads. It is the next great improvement since in Leeds tar paving was put down some forty years ago. There has always been a difficulty in the use of macadam, especially in London, Birmingham, and the large centres of population, because ordinary macadam produced so large an amount of dust. I will here mention one important item in connection with the use of macadam. The members of municipal councils in discussing street works, always go carefully into the capital and revenue account, but they never think, except those few whose minds are more comprehensive, of the loss which the dust and dirt cause, to shopkeepers, and the loss to vehicles, because it cannot be shown in the books as an item of wear and tear. Take London for instance, the wear and tear on omnibuses and horses has been reduced to a minimum. There is no doubt in my mind that the great reduction in omnibus fares in London is largely due to the great improvements in the roads. If councils would only consider the benefit that would accrue by considering the ratepayers as a whole, I think their work would be better done than by discussing the expenditure of a few thousands in the total, inasmuch as there are improvements that can be made in this way that cannot be stated in the digests of any accounts. The damage caused by clouds of dust in a large town to drapery and silk goods cannot be calculated. The paper of Mr. Petch is extremely valuable in showing that we have men in our Association who give time and thought to these things. As an old public engineer I feel grateful for the information that has been given, and I heartily support the proposer and seconder of the vote of thanks.

Mr. J. Lobley: I have great pleasure in supporting the vote of thanks to the author of this paper. Two years ago I was shown over the tar macadam works, and was mnch pleased with the work, as I have no doubt you will be to-day. It is pleasant to drive on these noiseless carriage-ways, and the absence of dust you will be able to notice. With regard to footpaths, it is agreeable to walk upon, the only drawback is that it is dark-coloured. You do not seem in Scarborough to adopt the system of using limestone chippings or spar on the top. In the Midlands we get a much lighter effect by doing so.

Mr. C. H. Cooper: There are a few points I should like to call attention to: one is as to the weight of the rollers the author uses. I have laid down a very large amount of tar-paved paths, but have not gone in for tarred macadam roads. We have always finished off with a heavier roller than we used in forming the foundation. Here they begin with a 10-ton roller, follow with a 7-cwt. roller, and finish off with a 2-ton horse roller, covering 6 feet of road, which gives a very small amount of pressure. In the case of the tar-paving, there does not appear to be anything added to the tar. In making tar paving for footways we have always been accustomed to add a little pitch, but that does not seem to be done here. I think it would be very interesting if the author gave the cost per foot run of making up his private roads. A great many private roads near London run to a serious price. In my district, I am pleased to say, the price has never exceeded 24*s.* per foot run of road, i. e. 12*s.* per foot frontage. The fact that this tar macadam is not suitable for main thoroughfares is a very serious drawback, and one we should be glad to hear more about. In Nottingham they seem to use tar macadam in their main thoroughfares, and I believe also in Sheffield they have a large portion of tar macadam roads. One interesting thing about tar macadam here, and in Nottingham, is that it has been used on very excessive gradients. We ought to be grateful to Mr. Fowler for alluding to the effect of these roads on the dust and traffic. The effect of reduction of resistance due to improved pavements has been to enable horses to carry considerably greater loads.

Mr. Creer: I heartily support the vote of thanks to Mr. Petch, and think the most interesting part of the paper is that referring to tar macadam. I am accustomed to hear members of my council after a visit to Scarborough lauding up the manner in which they macadamise the roads here, and holding them up as examples of what can be done at a moderate cost. I think Mr. Petch is to be congratulated on his roads, and the Corporation of Scarborough is also to be congratulated that they have a gentleman who is able to carry out their work so satisfactorily. I have been in the habit of storing up the tarred material in heaps for months, and I have always understood that storing improved its setting properties. I should like to know whether that is the experience here. I notice in the case of the tar paving in the Esplanade and Cromwell Gardens that the annual cost of maintenance is given as nil. I always understood, and found in my experience, that it was necessary every few years to tar and sand the surface of the material to preserve it, as the tar is apt to lose its binding qualities, and that during the ten years referred to, the tar would lose its power to hold the gravel or screenings together unless it was periodically coated with tar and sand.

Mr. R. Godfrey: I feel that the visit to Scarborough is one that will be very beneficial to every one concerned. The point I want to draw attention to is the paragraph in the paper stating that "the system of ventilation adopted for the past twenty years is by cast-iron pipes, varying from 4 to 6 inches diameter, carried up the gable ends of houses or other high buildings clear of all windows and chimneys; all surface ventilating grids have been abolished." As I said at Peterborough last week, to succeed in abolishing complaints you must go back to first principles. I believe all the artificial systems of ventilation will end in failure. Scarborough seems to have gone back to first principles long ago, and I wish we could do so in all the towns in the Midland counties. Here you have 250 of these vertical shafts; I say if you had 2500, all the better. Unfortunately we have no compulsory power given to us to erect these shafts up people's premises. I should like to see that power given to local authorities. We have the power to take a sewer through anybody's land, and we ought to be able to take it to its logical termination above the roofs of the houses. What smells were emitted from the vertical shafts would be eliminated more rapidly. I think it is demeaning to an authority to have to go cap in hand and say, Let us do it. As the custodians of the health of the district, it should be in the power of the authority to say, We will do it and we will pay you for it. The next time the officials of one of the large municipalities have a bill in the House of Commons, they ought to try and get a clause inserted, as a tentative application of the principle, giving an authority power to carry up these ventilating pipes by the side of houses. But with that will have to be abolished the clause compelling every house to have a syphon disconnecting it from the sewer. Trap every branch leading into that ventilated drain, but let there be a full draught right through. I hope the day is not far distant when we shall be able to carry that into effect.

Mr. J. T. Eayrs: I should like to ask if the author (Mr. Petch) will give the quantity of tar he mixes with the other material?

Mr. R. S. Rounthwaite: I would just like to say a word in support of the motion before the meeting conveying our thanks to Mr. Petch. I would like him in his reply to answer one or two questions in addition to the numerous questions already asked him. I should like to ask him why he prefers to mix *cold* tar with his hot stone rather than *hot* tar; and whether he uses any pitch or oil, or simply coal gas tar; also what is the nature of the stone he gets from the beach, and whether he finds it to be a suitable material, sufficiently porous to retain enough tar for adhesion? I have laid down a good deal of tar macadam, but I have always mixed pitch with the tar, and mixed it hot. I have found that on moderately steep gradients tar macadam becomes very slippery in frosty weather, and the cost of sanding is considerable. I have also laid down a large area of tar footpaths in our public parks, which have proved both satisfactory and economical. I should like also to ask Mr. Petch a question upon the ventilation of the sewers. He uses a large number of pipes carried up to the tops of the houses. My experience has been that pipes carried to this great height are not anything like so efficient for carrying off sewer gas as lower and wider shafts. The great majority of towns have shafts up to the road level only, and they are found to work very satisfactorily. In some cases it may be necessary to carry them up to the tops of the houses, but we have difficulty with the owners in obtaining consent. I should like to know whether any tests have been made with the anemometer as to the currents in these high shafts compared with low shafts.

Mr. Mallinson: I should like to know how these tar roads are paved, by what means the top coating is made to adhere to the lower coating.

Mr. Moore (Isle of Ely): I notice that the author says the cost of the paving for roadways exclusive of any foundation is 2*s.* per yard superficial, and for footpaths 1*s.* per yard superficial. Does that include the cost of the three coats?

Mr. Petch: Yes.

The President, in closing the discussion, said: I listened with great pleasure to the paper, and as it was read, jotted down a few things which occurred to me, but most of them have been referred to by previous speakers, with the exception of the Marine Drive. I will take those questions in the order in which they appear here. First the suggestion that all the surface ventilating grids should be abolished, strikes me as being a very drastic measure—if I may so term it—for a town of this kind to adopt. I should like to ask Mr. Petch whether he made any investigation of the currents of air in the sewers before the gratings were closed and since. I have for some time past been carrying on experiments with 4 and 6-inch pipes for testing the air currents at different temperatures, and also with different kinds of pipes. I have had these experiments made with bends and elbows, &c., such as we often find in ventilating shafts, especially in the speculative kind of buildings. My object was more particularly to ascertain the effect these bends had on air currents. It takes some time to make these experiments, but I hope shortly to be able to obtain reliable results from those experiments. If any Member feels inclined to undertake similar experiments, I shall be pleased to compare notes with him. I cannot altogether agree with Mr. Godfrey as to sewer ventilation, though I think with him that some power is needed to enable local authorities to carry sewer ventilating pipes up the sides of houses in certain cases. I know that Mr. Godfrey comes from a district which has a very perfect dual system of sewers, but he must not forget that some of the older towns have sewers of large size, which it would be difficult if not impracticable to ventilate by means of small pipes against houses.

Mr. Godfrey: I would make each house ventilate its own drains, but I would trap every branch that leads into that.

The President: With reference to the tar paving I have no doubt the evaporation of the moisture from the material, and the character of the material, have a good deal to do with its success in Scarborough. I have tried it with footways and was not satisfied with the result. It was laid on a clay subsoil. I attribute its failure to the clay on which it was laid, and to the fact that we did not evaporate the moisture from the material sufficiently. I should also like to know whether the amount of traffic in the tar paved streets has been ascertained. If any estimate can be formed either of the number of tons per yard of width of street, or the total number of vehicles per annum, and character of vehicles, it would give a basis for comparison. If Mr. Petch would be kind enough to supplement his paper with a section showing the draining of the undercliff at Holbeck it would be very useful. At Bournemouth the cliffs are suffering from the effects of the surface water, and if that can be stopped much valuable land will be saved, not only in Bournemouth but other seaside towns. Perhaps Mr. Petch would also kindly show the strata through which the drains are carried. I can only add my thanks to Mr. Petch, and also to his chief assistant, who read the paper, because without a good staff none of us can get good work done. The work in Scarborough reflects great credit upon Mr. Petch and his assistants, and I have great pleasure in putting this vote of thanks.

The vote of thanks to the author was carried with acclamation.

Mr. Petch, in reply, stated: The quantity of tar used in the preparation of the material is as follows:—1st coat, 1 gallon per superficial yard; 2nd coat, 1·14 gallon per superficial yard; 3rd coat, ·5 gallon per superficial yard. Total 2·64 gallons per superficial yard. We have little or no experience with tar paving on main thoroughfares; some main streets have been laid, two of which have been done quite recently, but these have not the heaviest traffic over them. The stones used vary very much in quality and kind, they are principally composed of old red sandstone, quartzite, basalt (whinstone, gneiss, calt grit, carboniferous limestones, ironstone, nodules, and granite, gathered along the base of the cliffs. The rollers used are as follows:—The 10-ton steam roller on the first and second coats of the carriage-ways, and on the third coat a 7-cwt. hand roller is used 2 feet wide and 2 feet diameter. After it is sufficiently set a horse roller 35 cwt., 6 feet wide and 2 feet 6 inches diameter, is used until well consolidated.

On the footpaths the first coat is rolled with the 7-cwt. roller before mentioned, and the second coat is rolled with a 2-cwt. roller, 2 feet wide and 18 inches diameter, and when sufficiently consolidated is rolled with a 5-cwt. hand roller, 2 feet wide and 18 inches diameter, and again rolled with the 7-cwt. roller. The cost per foot run for tar paving a private street 36 feet wide, including footpaths 7 feet wide, with 12 inches by 4 inches Yorkshire kerb, exclusive of the foundation, is 8*s.* per foot run. We find that the materials used make better work if allowed to remain in heaps for a period of three or four months, but in many cases we have used the undercoat immediately after being prepared. The heating of the stone is to evaporate all moisture and to assist in the incorporation, and cause the tar to adhere thoroughly to the materials. We prefer to use cold tar in preference to hot as all the lighter oils are retained. No pitch or other ingredients are mixed with the tar. There are only two coats used on the footpath work, the cost of which is 1*s.* per yard exclusive of the foundation. Previous to the adoption of this system of tar paving on footpaths, private firms who advocated their own systems laid down specimens of their work which was made with cold materials and boiled pitch, &c., and tar, gravel, and ashes being used. The last system tried was by heating the materials on hot plates, boiling the tar and mixing with pitch, then incorporating the liquid with the heated materials. This work lasted for about three years; it was then relaid on our present system twenty-seven years ago, and has lasted until this year; the cost of the repairs during the twenty-seven years has not been more than 1*s.* per square yard.

I may say that no tests have been made by the anemometer or any experiments as to air currents. The closing of the street grids was done many years ago, when there were only about nine or ten in existence; they were closed at different periods whenever any complaints arose about them, and as soon as they were closed the complaints ceased. We have some ventilating shafts 70 feet in height, and we find by experience in fixing these shafts that the higher they are the stronger the current.

The President has referred to data of traffic. We have not obtained any data or information as to the traffic, but generally in Scarborough the traffic is light as compared to many large towns, and the streets paved are not main thoroughfares, or where the traffic is very heavy.

In conclusion I have to thank the Association for the honour of their visit to Scarborough, and the interest they have taken in the question of the tar paving.

Mr. W. Millhouse, Water Engineer, then read the following paper:—

SCARBOROUGH WATER WORKS.

By WILLIAM MILLHOUSE, Assoc. M.Inst.C.E., Water Engineer.

In the year 1845, when the inhabitants of Scarborough were beginning to tire of waiting their turn for several hours at the public conduit by the Market Cross to draw water, a company was formed for the purpose of providing the town with a plentiful supply of pure water.

This was obtained from a spring at Cayton Bay, which had been previously utilised for working a corn mill. The mill and spring were bought and the mill-wheel was the first motor used for working the pumps, but for a short time only. Mr. Thomas Wicksteed having been called in, he advised that a Cornish Pumping-engine, capable of pumping 400,000 gallons per day, be put down, which was accordingly done, and in 1853 another similar engine capable of pumping 650,000 gallons per day was added to this station.

The engines are still in working order and held as a reserve in case of need.

In 1872, when the growth of the town demanded a further provision for its immediate needs, the old Company sank a well and put down a pumping plant at Osgodby, situate about a mile inland from Cayton Bay.

In 1878, when the Company proposed to bring water by gravitation from reservoirs to be constructed on Jugger Howe Beck, lying on the moors to the north of Scarborough, the Corporation bought the Water Works from the Company, and immediately proceeded, under the advice of Mr. Filliter, of Leeds, to construct new works at Irton, where a well was sunk and engines erected to pump the water into the new service reservoirs, which were built at the same time on Oliver's Mount.

CAYTON BAY.

The water at this station is obtained from an underground reservoir formed by a fault of 120 feet throw in the Oolite formation, by which the Oxford Clay is banked up against the calcareous grit.

The clay has been tunnelled through and the water conducted to a dam from which the engines draw their supply.

The yield from this source is about 1,000,000 gallons per day.

As the engines are of so old and well-known a type, they call for no special remarks here.

OSGODBY.

The water at these works is obtained from a well 10 feet in diameter, lined with brick, sunk 127 feet into the calcareous grit, with drifts in three directions driven from the bottom of the well.

The yield from this source varies between 580,000 and 865,000 gallons per day.

The engine is a Cornish Bull engine, placed directly over the well and capable of raising 600 gallons per minute, through a 12-inch main about one mile long to the Osgodby Hill Reservoir.

The head in the main is 205 feet, including 10 feet for friction.

Steam is supplied by two Lancashire boilers at 40 lbs. pressure.

IRTON WORKS.

The well at this station is 428 feet deep. The first 70 feet being 10 feet diameter and lined with cast-iron cylinders firmly bolted together and sunk down into the Kimmeridge Clay, where the bottom of the cylinders was closed in with cast-iron plates, and a bore continued for 28 feet lined with 24-inch tubes of cast iron, until the water was reached. A plug was fitted on the top of the 24-inch tubes to shut down the water.

The bore was sunk for 152 feet at 20 inches diameter, and 178 feet at 12 inches diameter, until the Oxford Clay was reached.

Well.	ft.
10 ft. cylinders	70
24 in. tube	28
20 in. rock	152
12 in. „	178
Total	428

Strata.	ft.	in.
Boulder Clay	53	6
Kimmeridge Clay	45	0
Upper calc. grit	46	6
Upper and lower limestones ..	120	6
Lower calc. grit	135	0
Changing to Oxford Clay ..	28	0
Total	428	0

The overflow from the well is about 1,000,000 gallons per day, and the engines have never materially lowered the water when pumping continuously day and night.

It has been proved by the author that the river Derwent keeps this strata continually supplied through fissures in the rock in the bed and sides of the river.

Having placed a dam across the entrance to one of the largest of these swallow-holes and stopped the water from going in, all the wells in the neighbourhood were dried up and the surface of the water in the Irton well was also lowered, but to so small an extent that it was considered the loss of this supply would not seriously affect it.

The engines at Irton are a pair of beam engines, double-acting, rotative and condensing, capable of lifting together, through a 13-inch main about 4 miles long, 1,000,000 gallons per day, either to the upper or lower reservoirs on Oliver's Mount.

The water is raised from the well into the condenser tanks by combined bucket and plunger pumps and passed through the condenser to the force pumps. The rams of the force pumps are pistons packed with gutta-percha rings in place of the leather packing originally designed.

The capacity of the pumps is 28·02 gallons per revolution, and the quantity delivered into the Mount Reservoir 27·25 gallons, being an efficiency of 97.

Air is fed into the air vessels by Wipperman's Injectors.

Steam is supplied by two Lancashire boilers with Fox's corrugated flues and Vicar's feeders. Coal is delivered at the works, into bins under cover, by a siding from the North Eastern Railway, thence conveyed in half-ton tramway wagons to the boilers.

The head in the main, above the gauge in the engine room, to the lower reservoir, is 240 feet, and this is increased 60 feet by friction when raising 800 gallons per minute.

The engines are 42 I.H.P. each, and the coal burnt averages 3·3 lbs. per I.H.P. when pumping to the lower reservoir.

RESERVOIRS.

The Service Reservoirs are three in number.

1. A high-level reservoir situate on the top of Oliver's Mount, 505 feet above Ordnance Datum. Capacity 1½ million gallons. This reservoir has just been covered with a roof of concrete. The

concrete is supported on rolled steel joists 12 feet apart, which rest on brick pillars. The concrete is covered with two coats of asphalte and finally with a covering of broken stone and gravel.

2. A low-level reservoir situate on the west side of Oliver's Mount, 338 feet above Ordnance Datum. Capacity 1½ million gallons.

This reservoir is covered, built of brick and lined with salt-glazed bricks of local manufacture. A bed of puddle is laid under the reservoir and round the sides. The cover is formed of brick arches carried by cast-iron girders resting on brick pillars, which stand on foundations formed by inverted groined arches bedded on Lias lime concrete.

This reservoir has remained perfectly sound, and is very easily kept clean and in order.

3. An open reservoir at Osgodby Hill, situate about two miles from Scarborough, and 337 feet above Ordnance Datum. Capacity 4½ million gallons. A new floor has recently been laid in this reservoir, the area being 5354 square yards. The floor was formed of concrete 6 inches thick, made of 4 parts broken brick, 2 parts small gravel and sand, to one part of cement, and topped with one inch of blue granite chips passed through a riddle of ⅜ inch mesh, and cement 2 to 1. This has formed a solid and smooth floor, capable of standing the thorough sweeping and cleansing that may become necessary.

All the reservoirs are connected and the mains so arranged that the engines can pump into any reservoir or direct into the town.

Supply.

The total supply of the town is as follows:—

	Gallons.
Cayton Bay, per day	1,000,000
Osgodby Well	900,000
Irton Well	1,160,000
Total	3,060,000

all of which can be pumped into the reservoirs by the engine power at command.

The largest daily consumption is in August, when it has reached 1¼ million gallons, the number of inhabitants being about 50,000. After deducting water used for trade and similar purposes, the consumption per head per day equalled 20¼ gallons.

ANALYSES.

	Cayton.	Osgodby.	Irton.
	Grains per gallon.	Grains per gallon.	Grains per gallon.
Total solid residue	22·14	22·00	15·70
Chlorine	3·80	2·20	1·55
Nitrogen as nitrites	..	None	None
Nitrogen as nitrates	..	·335	·078
Oxygen absorbed in 2 minutes	..	None	·011
" " 4 "	..	·033	·024
Phosphoric acid	..	Merest trace	None
Poisonous metals	Absent	Absent	Absent
	Parts per million.	Parts per million.	Parts per million.
Free ammonia	None	·0064	·0054
Albuminoid ammonia	·02	·005	·004
	Degrees, Clark.	Degrees, Clark.	Degrees, Clark.
Temporary hardness	11·00	11·2	10·6
Permanent "	5·00	5·00	4·4
Total	16·00	16·20	15·0

ANALYSIS OF SOLID RESIDUE.

	Cayton.	Osgodby.	Irton.
	Grains per gallon.	Grains per gallon.	Grains per gallon.
Silica	·35	·56	·21
Oxide of iron and alumina ..	·19	·36	trace.
Carbonate of lime	10·43	8·27	8·93
Sulphate of lime	2·94	3·41	2·17
Nitrate of lime	—	1·96	·45
Carbonate of magnesia	3·22	2·58	1·37
Chloride of sodium	3·85	3·62	2·55
Sulphate of sodium	·32	—	—
Minor constituents and loss ..	·84	1·24	·02
	22·14	22·00	15·70

DISTRIBUTION.

Trunk mains conduct the water through the chief thoroughfares of the town, and each street branching off has a main with its own sluice-valve for turning off, and flushing cock at the end. The flushing is regularly attended to, and is found to give better results than allowing the water to circulate by having the bye-mains connected to the trunk mains at both ends.

On account of the hilly nature of the town, the author has introduced pressure reducers on two of the trunk mains, to relieve the strain on the house fittings. One reducer, a 5-inch, is fixed on the 8-inch main from the high-level reservoir, and reduces the pressure from 110 lb. to 60 lb. on the square inch. The other reducer, also a 5-inch, is fixed on the 7-inch main that supplies the Sandside district, and reduces the pressure from 80 lb. to 50 lb. on the square inch. Both have answered perfectly and caused no trouble.

Meters.

The meters in use are Siemen's pattern, made by Guest and Chrimes. With constant attention these meters give fairly good results, especially where a regular supply passes through them.

Every meter is tested before it is sent out, and also immediately it is brought in, and a careful record of the testing is kept. This record has proved most useful, especially in cases of dispute with dissatisfied consumers.

Regular inspection for the prevention of waste is carried on daily, with night inspection at short intervals.

At night each main is tested alternately by closing and sounding the street valve. Water passing is at once detected, and by sounding the stop taps in the street the leakage is localised and reported, when the day inspectors complete the search by internal examination in the day-time.

A Deacon's meter has lately been fixed so as to control the oldest part of the town, and has proved a very useful instrument for saving water. Leakages from the mains in quantity are at once shown on the diagrams, and the work of the inspectors most effectively controlled. The waste from fittings in this district has already been reduced about 3000 gallons per hour. This, however, will only be maintained by most constant attention.

Rules and Regulations have been adopted to ensure the use of good materials and workmanship in relation to water fittings, and all taps are tested and stamped by the Water Department before they are fixed, although the Local Government Board would not sanction a clause in the Regulations making this compulsory.

We have no trouble in getting the plumbers to send in the taps for examination, as they find it is to their advantage to do so, a large number of taps having to be returned to the makers as defective.

The following clause was inserted in the Scarborough Improvement Act 1889, on the recommendation of the author: "The Corporation shall not be bound to begin to supply water to any person in respect of any premises unless and until the Water Regulations of the Corporation applicable to such premises shall have been duly complied with."

Main Scraping.

As the author has been obliged to either abandon or clear an 8-inch main, the first one laid by the old Company, it may be of interest to give some data concerning the work.

The total length of the main to be cleared was 2240 yards, the diameter of which had become reduced to 5 inches by a hard incrustation, something after the form of coral in structure, and composed of lime, silt, and iron rust, the pipes not having been coated as at present is customary.

Scrapers and hatchboxes were obtained, and the latter fixed, one at each end of the main, and one half way between, near to a water-course, to act as a flush-out.

All being ready the scraper was placed in the main, near to the Osgodby Reservoir, and the water turned on giving a pressure behind the scraper of 30 lb. to the square inch, which, however, failed to move it.

An engine was then started to pump, and the pressure got up to 59 lb. on the square inch with a like result. The scraper was taken out and replaced in the main at the Scarborough end. Water was then turned on from the high level reservoir which gave a pressure of 95 lb. to the square inch. Immediately the scraper started and got through to the flush-out, half way on the main, in a few minutes, the pressure falling to 65 lb. on the square inch during the passage of the scraper. This part of the main must have been fairly clear, but the scraper brought some stones and a large piece of lead along with it. The scraper, having had the leather clacks, &c., attended to, was put into the main again and the hatchbox cover bolted on. The water was again turned on, but not having an open end on the main for the water to get clear away, slow progress was made, and finally the scraper stopped at a bad joint. Having cut it out and replaced it, the main was opened out at the end and steady progress was made until the scraping was completed.

The rumbling noise made by the scraper when working can easily be heard on the surface of the ground by any one walking above it, and the pace at which it travelled, in our case, was a very fast walk. The amount of silt brought out of the main was astonishing. The scraper has been put through the main again this year, and it is intended that the same shall be done annually to keep the main in good order.

The cost of the first scraping was:—

	£	s.	d.
Plant, including hatchboxes and fixing same ..	48	18	2
Scraping main	13	0	4
	£61	18	6

DISCUSSION.

Mr. **Baker**: I shall have very great pleasure in proposing a vote of thanks to Mr. Millhouse for his interesting paper on the waterworks. In doing so I should like to make a few remarks upon one or two points in connection with the paper. I notice as to the Irton works, that the depth of the bore hole is given as 428 feet. There is no information given as to whether any test has been made as to the depth of the bore hole now. There is some considerable depth below the tubing, and from my experience I have found that a bore hole has filled up rapidly through some strata. It may not be so in this case, but it would be interesting to know whether he has any check as to the depth of the bore holes now. As to the water supplied I take it the quantities given are the maximum quantities that can be supplied. After deducting water for trade and other purposes the consumption per head per day equals 20¼ gallons, while the total consumption amounts to 25 gallons per head. I do not know whether Scarborough uses a large amount of water for trade and other purposes but it strikes me as an excessive amount for a town of this character. I take it the total solids in the water, 1·93, are given before it is treated by the Porter-Clark process. As to the distribution, I find there is a remark as regards circulation. I should like to ask how long the circulation has been cut off, and what experience has been obtained as to the amount of deposit on the mains. Because it seems to me from what I have seen in other towns that we are rather inclined to go in for circulation than have the dead ends, as they increase the deposits unless they are very frequently washed out, and it means the pipes would very soon be filled up. As to the meters, with constant attention those used here give fairly good results. We all know that the Siemens meter is one of the best meters for registering the flow of water under pressure, but with water with a considerable amount of deposit, from lime or peat, their mechanism being very delicate, they very soon get out of order with a water that is charged with foreign matter of that sort. I should like to ask whether you have ever tried any other form of meter besides the Siemens meter. There is no doubt in some respects the Siemens meter is the best, but for water that is heavily charged I believe the Tyler meter is the best, as there is no chemical action, the pan being made of vulcanite, and therefore very little deposit can take place. Besides, they are easily cleaned and can be adjusted without being taken to pieces. The registering of taps seems to me to be a peculiar idea, and I do not know of any other town where it is done. It is usual, I think, to specify certain makers' names for the taps, and these are only to be used, which does away with taps being sent backwards and forwards. The main-scraping is a rather interesting part of the paper, as it seems to me to be useful. I should like to ask whether the cost of cleaning includes every expense, and how often it is done, whether annually or more frequently.

Mr. A. M. Fowler: There are one or two matters the paper is rather incomplete upon. There is no mention of filter beds in the paper, and so I suppose the water is not filtered. If the water is taken direct fron the wells, that will account for the deposit in the mains. With regard to distribution, I do not approve of dead ends. I am now carrying out two waterworks in this district, and in both cases the pipes allow circulation. It is always interesting to know the cost of pumping, and it will be useful if Mr. Millhouse will give the cost of pumping per foot of lift. As to the pressure, I should like to know the minimum pressure, because in a town like Scarborough the question of fire is important; and in an undulating town like this the pressure must be more severe in some parts than in others. I have generally reduced the pressure to 80 lb. per square inch on the main, which is a good working pressure, and sufficient in the case of fire. Again, if the pressure is too severe it damages the fittings seriously. The stamping of fittings is an excellent provision, and especially important where you have a strong pressure. In Manchester, they not only have the fittings stamped, but have authorised plumbers throughout the town, and no man can touch a water- or gas-pipe unless he is an authorised plumber.

The President: I have much pleasure in putting this vote of thanks. I would like to make one remark as to the testing of water fittings. It is not only good for the water companies, it is good for the consumers and the local authorities. Most of the London water companies have tested the fittings for some years, and the manufacturers, I believe, are in favour of the system. They send the fittings to the companies' depots where they are tested and brought back with the official stamp of the water company on them. I would go a little further. I think it would be a good thing if sanitary authorities had power to test and stamp the sanitary fittings before they are put in.

The vote of thanks to the author was passed with acclamation.

Mr. Millhouse, in reply, said: Our water being a lime water has a deposit and, as I dare say you know, all these waters are the worse for standing. We find by experience that the draw from the branch mains in Scarborough is not sufficient for thorough circulation. I find that flushing the mains is more satisfactory.

I have had complaints from the best parts of the town of the water becoming stale. I dare say in some towns with a large manufacturing consumption it may be different.

Our meters work very well and give fairly satisfactory results where a regular and reasonable quantity of water is passing through them, but when the supply is only small and intermittent the meters do not always register the flow.

I am now trying the meters made by Kent, Schönheyder, and the London Water Meter Company, for their wearing qualities under the severe action of our water.

With regard to the testing of the taps, that is an idea of my own as regards Scarborough, and as taps are frequently found faulty on inspection and examination, I think it has proved a benefit to all parties.

We do not filter the water, as it is perfectly bright and clear when pumped from the wells, lime only being thrown down when it is kept stored in the reservoirs.

The pressure reducers are so adjusted that a pressure of not less than 50 lb. on the square inch is always maintained, and seldom more than 80 lb.

My statement as to the quantity of water used per head per day, viz. 20¼ gallons, was taken from my notes made at the time, in August last. This quantity does not include the water used for trade, watering the streets, flushing the sewers, or by the railway company. Having worked it out carefully at the time I think it will prove correct. The consumption may appear high, but Scarborough being a water-closet town will account for that, and if syphon cisterns were adopted the consumption would be largely increased.

The total cost of supplying water to the town of Scarborough per thousand gallons is as follows:—

	d.
Interest on capital	4·37
Pumping	1·15
Town works	·35
Rates and taxes	·47
Salaries and collection of rate	·32
Sundries	·23
Total	6·89

The reason for the high charge on capital account is that the Corporation purchased the waterworks from a company at a price (150,000*l.*) based on the annual income of the company, and a further sum of 50,000*l* has been expended since the transfer.

The PRESIDENT: Before we leave for the *Bull* Hotel I would ask you to pass a vote of thanks to the Mayor and Corporation for permitting us to have the use of this chamber to hold our meeting in. I will put that formally because I know you will pass it unanimously.

The proposition was adopted with acclamation.

The Members then proceeded to the tar paving yard, where the process of mixing the hot stone and cold tar was watched with much interest. Visits were also paid to the stables, which were admirably arranged, and to the Floorcloth Company's Works, after which the Members adjourned to the Bull Hotel, as the guests of the Mayor, Lieut.-Colonel Steble, for luncheon. The Ex-Mayor (Mr. Councillor H. Darley) presided, and in addition to the Members of the Association attending the meeting, most of the members of the Scarborough Corporation were present.

A number of the Members subsequently visited the Aquarium, the Spa, the South Cliff Tramway, Holbeck Gardens, and other sights of the "queen of watering places."

ANNUAL MEETING IN BURY.

July 21st, 22nd, and 23rd, 1892.

ADDRESS OF THE PRESIDENT.

MR. J. CARTWRIGHT, M. Inst. C.E., F.S.I., BOROUGH AND WATER ENGINEER, BURY.

GENTLEMEN,—The Association of Municipal and County Engineers has so advanced in numbers, made its influence so widely felt in the legislation of the sanitary requirements of the day, and so grown in the estimation of the municipalities and other governing bodies throughout the kingdom, that with each succeeding year of its existence its importance and responsibilities increase. To be elected its President is the highest compliment a Municipal or County Engineer can receive; for the honour conferred upon me and the borough I represent, I tender you my sincere and hearty thanks. I take the post with no little misgiving as to my fitness to discharge its important functions, but with the full assurance that I shall receive every assistance needful from the Council and the Members generally.

Former Presidents of this Association, following in the steps of the President of what we are all justly proud to designate "the parent Society," the Institution of Civil Engineers, have as a rule dwelt in their addresses upon some special points of practice with which they were immediately concerned, or some engineering feat of skill which was occupying the attention of the country at the time. If I do not follow on the orthodox lines, it is not for lack of matter, for without going outside the county in which we are met to-day, there are at the present moment vast works of engineering skill in active operation or approaching completion which will form a record second to none the world has witnessed, and which will add much to the fame of the civil engineer during the Victorian era. To enumerate the numerous works of sewage purification, reservoir construction, and other works which many of our Lancashire towns are actually engaged in constructing, and which in the aggregate represent an enormous sum of money, would form no mean record. Of these I will mention four works, each of which would form a theme in themselves, viz. the Preston Docks, the Manchester water supply from Lake Thirlemere, the Manchester Ship Canal, and lastly that magnificent undertaking, the difficulties of which have been so numerous, but which, thanks to one of our honoured members, whom we are delighted to see with us to-day, has been brought to a successful issue—I allude to the impounding and conveying to Liverpool of the water of the Vyrnwy.

My remarks to-day will be confined to the advantages of our Association, the relationship of the members to it, to the authorities they serve, the duties and responsibilities of a municipal engineer to the community, and the duty of the representatives and the community towards the engineers. From an experience of nigh 20 years (having joined the Society at its commencement) I can testify to the benefits to be derived from this Association, not only to the members, but also through them to the authorities they serve. The reading of papers, the taking part in the discussion in however humble a way, and the listening to the opinions of those actually engaged upon the works under consideration, are of the greatest advantage to the engineer, oft informing the mind on points of doubtful practice, and assisting him in such a way as nothing else could so well do. It may be that the information he is anxious to obtain is not prominently to the fore at the particular time he seeks it; but even if so, an observant man can always carry away from these meetings some germ of thought to fructify in after days. It appears to be one of the outcomes of our present day for men to bind themselves together to promote their general weal, and though I have great faith in silent thought and private research, I readily admit that associations such as this, whose fundamental object is to obtain and distribute knowledge on points of practice, are to be commended.

It may be said that engineers in past days designed and executed works of skill without this intercourse. It is said of Brindley (who, by the way, successfully carried out the construction of the Bridgwater Canal, a Lancashire work of no mean order in its day) that when puzzled and in doubt upon any point of practice he went to bed and thought steadily for a day or two; but we should hardly consider this plan suitable to these modern days. If Brindley had belonged to such an Association as this he might have solved the problems that so puzzled him in a more cheerful way than lying in bed. However that may be, there is little doubt that much knowledge and experience gained in former days has been lost to us from a lack of the means of recording it. We know that the ancient Egyptians and Assyrians had knowledge of the casting of bronzes and the removal of heavy materials of which we to this day remain ignorant; whilst therefore encouraging quiet thought and study, without which it is scarcely possible to succeed, I put in a plea for the support of this Association, which enables you to add to your knowledge the experiences of others, by visiting their works and hearing their views, and at the same time provides the opportunity of submitting your own works and views to the test of those whose opinions are worth hearing.

Passing to the importance of the duties and responsibilities of the sanitary engineer, these, if carried out aright, have a beneficial bearing upon the health and prosperity of the people. The demolition of insanitary property, the cleansing of slums, the removal of refuse from the vicinity of dwellings, the introduction of pure air into our dwellings and workshops, the erection of baths and wash-houses, the provision of libraries, museums, art galleries, and places of public recreation, all tend to the improvement of the community both physically and morally, and, notwithstanding increased expenditure, improved pavements, new and better means of communication, improved methods of lighting, heating, and ventilating, cheapening the production of mechanical power, increasing the supply of fresh water, bring in their wake increased prosperity and means of happiness.

To competently discharge the duties of his office the engineer must have a suitable training. It is unnecessary to emphasise the claims of theoretical or technical instruction. The country is alive to the needs, and has met the want. At school or college our younger men have only to desire and they gain the knowledge they seek, but a training essential to an engineer must be acquired after leaving school or college. No amount of lecturing will make the student proficient in filing and chipping; no correct knowledge of the nature of materials can be gained otherwise than by handling them. The knowledge of the component parts and arrangements of a steam engine, a boiler, a pump, a dynamo, or any other product of mechanism, is more completely acquired by one careful inspection of the article than by fifty lectures on its construction. No written description of concrete, mixing of puddle, preparation of foundation whether in trench, tunnel, or excavation, of road making or house refuse disposal is of half as much avail as an inspection during operation.

The municipal engineer must also comprehend mind as well as matter; although the country is coming to the opinion that there is need of sanitary reform, still he will find prejudices to subdue, obstructions to surmount, and difficulties to overcome. There are members of sanitary authorities who are elected and accept the office for the sole purpose of reducing or "keeping down" the rates, and woe to the peace of mind of the engineer who is called upon to serve an authority composed of such men; men who, regardless of the health and comfort of the inhabitants and unmindful of their duties as judicial expenders, seek by an ostentatious display of false economy to pose as the people's best friends. Such authorities as these are generally imbued with the sentiment that they have little or no need of a skilled engineer. Their principal ambition is but to evade the law and not to conform to it, by doing as little work and paying as little in salaries as possible. This idea I am thankful to see is weakening; sanitary bodies are gradually recognising the force of the penny wise and the pound foolish problem, and trained engineers of practical experience, of sound education, and common sense, are increasing in demand.

It is for us as an Association to assist in fitting our younger engineers to meet this new order of things. Like that of Mr. Gilbert's policeman, the life of the surveyor to an average sanitary authority cannot be called "a happy one"; the number and differences of temperament, the constant change of his board or council, renders his position ofttimes one of difficulty, doubt, and anxiety. It is said that the proper study of mankind is Man. This sentiment I commend to the municipal and county engineer, who if he knows not his fellow men and has all knowledge besides, is not likely to succeed.

Passing from the engineer to his authority and the community. We may have competent engineers able and willing to devote their energies to the carrying out of sanitary reforms, but if the community and their representatives do not truly understand their duties the efforts of the engineer will be minimised if not altogether lost. Why does a sanitary authority exist at all? Simply because by the springing up of a community the individual can no longer control his surroundings; could he do this he would in self-defence look to the sanitary conditions about him, but since it is impossible for him to purify the atmosphere, or the rivers, or efficiently dispose of large quantities of sewage and refuse, or carry out the thousand needs demanded where there is an aggregation of people, the legislature has wisely determined that where this condition exists, the community collectively shall do what the individual cannot do—hence the formation of an authority.

It is conclusively established, though there are differences of climate, of habits and surroundings, which militate against the comfort of one district as compared with another, that the advancement of medical and sanitary science is such as to make it possible to have an increased health rate and a reduced death rate. Whether the time will ever come when our knowledge and application of that knowledge will be so exact as to bring about the perfection of the human being, we cannot tell; but the knowledge we already have proves that the fate of man is largely in his own hands, and that if he used the knowledge he has, the world would speedily change for the better. The duty of the sanitary authority is simple and definite: it is not to use the authority as a club to promote the tenets or creeds or opinions of any sect or party; it is to carry out the various Public Health and other Acts, which have for their object the improvement of the health and comfort of the people; to this end and to no other should the members of every authority devote their energies.

On economical grounds alone it is to the advantage of a community to spend a portion of its earnings on the sanitary improvements of its district; in a word, to raise the district or borough rate, and to decrease the poor and police rates. Statistics clearly show that the expenditure in the larger towns has resulted in a saving to the community, and that the neglect of expenditure on needful improvements has resulted in loss and suffering. Who can over-estimate the benefits accrued in our large and crowded centres by the introduction of pure air and water, the widening of thoroughfares and the attendant demolition of hot-beds of vice and filth, the establishment of parks, open spaces, and places of recreation for the rising generation? and yet the difficulties met with in large bodies of people when such improvements are mooted are many, and the originators of them are subjected to all kinds of abuse and misrepresentation.

Roads, sewers, and means of water supply have been, and still are, constructed on too meagre a scale. A few years pass, and the works prove inadequate; then the town is forced to spend large sums in acquiring additional property, which has often greatly increased in value through the former improvement, it may be. Many instances could be recorded where, owing to such increased values, improvements have been delayed or so modified as to render them of little value beyond temporary benefit, or perhaps permanently shelved altogether. An experience of thirty years in municipal affairs has shown me the error of procrastination. The longer necessary improvements are delayed (and where is the town not requiring improvement in some form?) the worse it will be—the health, the happiness, the prosperity of the community will suffer.

Though sanitary science is making headway in our midst, as is shown by the interest taken by a large number of people in the transactions of the Institution of Civil Engineers, the British Association for the Advancement of Science, the Sanitary Institute, our own Association, and various other kindred societies, still there exists much ignorance in matters pertaining to public health. There is plenty of work for our scientists, philanthropists, and teachers of all grades. The bulk of the people need to be shown that money expended on the improvement of sanitary conditions is money well invested, that it is to their interest for such works to be of the best and most perfect description, and that as by their nature such undertakings must necessarily be costly, it is the duty of their representatives to obtain the best advice. It is better to pay a few hundred pounds in salaries than to spend thousands on imperfect works designed by incompetent and less remunerated advisers.

There are however municipalities who have grasped the importance of following the dictates of true sanitary science, and who stand as beacon lights to less favoured localities. The vast sums of money spent upon sanitary improvements in London, Liverpool, Manchester, Birmingham, Leicester, and other large towns, bear witness alike to the knowledge and enterprise of their rulers and advisers. There are also smaller communities who, according to the means at their disposal, are endeavouring to pursue the same policy; amongst these I claim a place for the borough in which you are met, and to establish that claim I will briefly enumerate the principal works executed or contemplated during the sixteen years of its incorporation.

Not to take up your time unnecessarily, I must refer you to the paper I read before this Association in 1883, when you had a district meeting here.* At the date referred to we were entering upon a large expenditure for the repavement of our streets with granite and wood. The opinions I then put forth as to the economy of these pavements have been fully proved. In St. Mary's Gate the granite laid down in 1882 has not had 1*d.* spent in repairs, and the same remark applies to the wood pavement in Fleet Street laid in the same year. Both the wood and the granite have been laid upon concrete foundations, as explained in the paper already quoted. You will inspect the laying of these pavements to-day. With regard to our waterworks, since 1883 two additional Acts of Parliament have been obtained, one in 1885 and the other in 1889. The latter Act gave power to acquire land for the construction of a new reservoir on the Whitewell Brook (a tributary of the Irwell) situate in the townships of Cliviger and Higher Booths in the Forest of Rossendale. The whole of the land has been acquired, and you are invited to inspect the works in construction.

Notwithstanding the advancements made in electric lighting, the gasworks have been extended since your last visit, and powers obtained by Act of Parliament in 1890 to construct a branch railway from the main line of the Lancashire and Yorkshire Railway to the gasworks. This railway is in active progress and you are invited to inspect those works.

As is known to some of the older members, Bury was one of the pioneers in erecting destructor furnaces, and though we have not adopted any recent improvements, the furnaces are worth a visit, showing a compact and neat arrangement. The Corporation have decided that the time has arrived to extend these furnaces, and I have been in communication with the chief makers with a view of informing myself as to their merits, and I am enabled, by the kindness of the makers, to show plans and models of the newest designs of furnace. The exhibits are open to your inspection, and they are from the well-known firms of Messrs. Manlove, Alliot, & Co., Messrs. Goddard, Massey, and Warner, Messrs. Horsfall, of Leeds, and Mr. Whileys, of Manchester, the latter being largely adopted by the Corporation of Manchester; there is also the Acme of Messrs. Royle. I will not enter into the merits of these various furnaces, but leave you to draw your own conclusions upon examination.

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* See 'Proceedings,' vol. x. 1883–4.

The disposal of sewage, the improvement and the purification of streams, the lessening of smoke pollution, the demolition of insanitary dwellings, and other important matters are having the serious consideration of the Corporation.

Turning from what may be classified as the active agencies of life-saving and health-improving works, I pass to another group calculated to bless and aid those who dwell amongst large populations, and which I may properly term "educational agencies." Since your former visit the inhabitants have subscribed no less a sum than 25,000*l.* for the establishment of recreation grounds, &c. In addition, two private individuals have expended a sum estimated at 20,000*l.*, and one of them has further endowed one of the grounds with a sum of 5000*l.* for its maintenance. The scheme was worked by a committee outside the Corporation, but I was privileged to design and superintend the construction of the grounds. The result is, we have four parks at the points of the compass, handed over to the borough free of cost, the Corporation undertaking to preserve the same for the use and enjoyment of the public. You are invited to view these grounds, in one case under happy auspices. Preparations are on hand for the erection of an additional swimming bath, it being the intention of the Corporation to extend and encourage the uses of the bath as an educational adjunct to the public school teaching. It has been decided to expend a sum bordering upon 10,000*l.* on erecting technical schools. The land has been acquired upon favourable terms, not only for the schools but for the addition of art gallery, library, museum, &c., when the need arrives for these buildings. The drawings of the school are on view.

The growing needs of the administration of the town has led the Council to consider the advisability of the erection of new municipal buildings, as also new market and abattoirs. Competition drawings for these have been obtained and are open to your inspection. The drawings are of great merit and are worthy of your examination, The premium drawing for the municipal buildings received distinction by being exhibited in the "Academy" this year.

The works either in active progress, or which it is intended at no distant date to commence, are estimated to cost not less than a quarter of a million ; whilst the markets and municipal buildings are estimated to cost 72,000*l.* In addition to these capital expenditures, there has been expended on construction of new streets, paid for by the owners of property during the same period, 104,000*l.*

It is only right to observe that during the years occupied with these works, involving such large present and prospectal expenditures, Bury has not been an increasing town, that is to say, it has not been enabled to carry on these works and to formulate these schemes because of the increase of its population or rateable value. The enterprise has taken place rather in the face of decay in some of its chief industries and in spite of many drawbacks. Notwithstanding Bury, has done wisely in these matters and has set an example worthy of imitation by other towns.

A word now as to the papers to be read. I will not anticipate the discussions and deductions that will be drawn from them, but only remark how practical they are, touching upon questions that are pressing upon our attention. My personal thanks are due to those gentlemen who have so readily responded to the request to give us these papers, as also to the gentlemen who have sent us the models and drawings, and the sanitary appliances exhibited at the Town's Yard.

I have not enlarged upon the many branches that properly come within the scope of the profession of a civil engineer, viz. hydraulic, naval, mechanical, mining, and electrical sciences, of all of which we, as Municipal and County Engineers, are expected to know something, but have contented myself with making a few practical though desultory remarks upon our status and responsibilities, and the relationship we bear to the Association and to the community. I trust you will not consider that I have taken too gloomy a view of the situation; if any conclude so, let me disabuse their minds by saying that there is every encouragement to go forward. We have only to compare the advancements made in the common necessities of our everyday life to see this is so. Compare the tallow dips of our grandmothers with the gas and electric light of our own day; the tinder-box with the lucifer match; the cobbles of fifty years ago with our improved wood, asphalte, and granite pavements; the advance in the speed of steamships; the remarkable progress of the locomotive.

I will now conclude with the observation that the capacity of man's invention is unlimited. As an illustration, take the recent advancements made in the science of electricity. Since our last annual meeting, the exhibitions at Frankfort and London have demonstrated how much may be done in lighting our streets and buildings, and in the generation and transmission of motive power, exemplifying with much force Tennyson's lines—

> "The thoughts of men are widened with the process of the suns."

As in all other sciences and professions, so in our own immediate sphere of labour—skill, application, and perseverance must prevail and bring success. The Institution of Civil Engineers is by consent the representative head of the civil engineering profession, but to the branch of engineering devoted to sanitary science, our own Association has become and will continue to be a power and help. I enter upon my year of office determined, with your aid, to maintain the usefulness of the Association; and, again thanking you for the confidence reposed in me, I trust that the ensuing year will be a prosperous one for the Association, a year of progress and success, creating new friendships and cementing old ones.

Mr. J. Lemon: It is not usual to discuss the address of the President, but I think we shall be wanting in our duty if we do not pass a very cordial vote of thanks to him for his very instructive address. It is no easy matter to prepare an address of this character, considering that previous Presidents have travelled over the same ground; but I am very pleased to see that the President has brought before the members what I call the business aspect of our profession. A man may be a very clever engineer, but unless he is a man of business he has very little chance of succeeding in life. Having regard to the fact that he has to meet with all conditions of men in his professional duty, if he has no tact and judgment, there is very little chance of success. I remember very well walking down a street with a friend of mine, and as we passed a certain building his remarking, "That is a very fine building." I said, "Don't you remember a few years ago criticising it very adversely?" and he said, "Oh yes, but I have had to design one myself since." Those who have had to prepare an address of this character can appreciate the ability of Mr. Cartwright's address. I beg to propose a cordial vote of thanks to the President for his able address. I think it shows that this Association never makes a mistake. I do not know of any occasion when we have put a president in office where we have not had to congratulate ourselves at the end of his year of office, and I am sure that will be the case, sir, when you vacate the chair.

Mr. G. F. Deacon: I have rarely heard a paper which appears to offer so much real practical good advice as the address we have heard from the President this morning, and I beg to second the vote of thanks to him.

The vote was unanimously passed.

STREET TRAMWAYS AND ELECTRIC TRACTION.

By J. H. COX, M. Inst. C.E.

The first tramway in England was laid by Mr. G. F. Train in 1860, at Birkenhead, by permission of the Birkenhead Commissioners, but it was not viewed with much favour by the public, and therefore it was not until 1868 that an Act of Parliament was obtained authorising the construction at Liverpool of the first English system of street tramways for passenger traffic.

Since that date they have spread very rapidly all over the country, until the total length has reached over 1000 miles, representing an invested capital of more than 14 millions.

Many different systems of tram-rails have been adopted, the earlier lines being laid with light wrought-iron rails on longitudinal or transverse wood sleepers. The cars at first were all drawn by horses, but as steam engines became introduced about 1876, engineers were compelled to construct the permanent way in a more substantial manner. Wood sleepers were discarded for metallic ways, and iron rails were superseded by steel.

Steam engines have done good service on tramways, especially in those towns where the gradients are too steep to be worked by horse power, but they are very destructive to the permanent way and are not entirely free from other objections, such as noise, smoke, steam, dust, and smell.

It should not be forgotten that steam engines have not only to haul the heavy cars and passengers up these hills, but they have their own ponderous weight to drag up likewise, and on the downward journey the everlasting jerks when the brake is applied are a source of damage both to the engines and the permanent way.

It may be interesting to some of you to have the figures showing the cost of maintenance for the Manchester Road tramway in Bradford, which has been worked by steam power for the last seven years. The rails are of steel 7 inches deep, girder pattern, weighing 103 lbs. to the yard, laid on concrete foundation, and the road is paved with granite setts from kerb to kerb. The line is 2 miles 16 yards in length, 1 mile 789 yards being double line and 987 yards single line. Line opened 5th September, 1884.

			Per mile of single line.		
			£	s.	d.
(3 months only)	1884	Cost of maintenance, rails and paving	2	12	4
	1885	" " " "	8	14	10
	1886	" " " "	17	3	8
	1887	" " " "	12	14	8
	1888	" " " "	40	19	3
	1889	" " " "	44	10	11
	1890	" " " "	55	18	2
	1891	" " " "	42	12	5
(6 months ending June 30)	1892	" " " "	38	10	9

The actual wear caused by a 10 minutes' service of cars on the tread of the rail up to the present time is $\frac{5}{16}$ of an inch on the single line and practically the same on the double portion. The engines are Green's and weigh 12 tons. The bogie cars carry 58 passengers and weigh 8 tons when loaded with passengers.

The excessive cost of maintaining tramways worked by steam has caused many tramway authorities to look in the direction of cable haulage and electricity for deliverance from their troubles; and under suitable circumstances these modes of traction have already proved very successful.

Those Members of this Association who attended the District Meeting in Edinburgh in the autumn of 1890, saw a capital example of the cable system in operation in that city, and they were also favoured with a most interesting paper on the subject by Mr. Colam, the engineer.

There is no need to repeat to an audience like this the many advantages which may reasonably be urged in favour of the cable system when applied to tram routes with severe gradients in populous districts which are able to support a very rapid service of cars; but there are very few tram routes, except in the largest towns, which can maintain a five minutes' service which is necessary to make cable haulage a complete success.

The Bradford Corporation were reluctantly compelled to drop the idea of introducing this system into Bradford for the projected tramway in the Wakefield Road district, mainly because of the difficulty of keeping up a rapid service of cars, and inquiries were therefore started as to the cost and capabilities of electricity as a motive power for working tramways on steep gradients.

Electric traction, as you know, has made wonderful strides since Dr. Siemens laid the first electric tramway at Berlin. Only one decade has passed since then, and now upwards of 3000 miles of lines are worked by electricity in America alone. Our American cousins appear to live and move at a high pressure rate, and do not stick at forming a network of wires over their streets, so long as it facilitates locomotion; but in Europe we proceed more cautiously, and there is little doubt that these objectionable overhead wires have considerably interfered with the progress of electric traction on this side of the Atlantic.

With electricity as a motive power, we have the choice of the proverbial three courses. First, to work by means of storage batteries placed under the car seats, as at Birmingham; secondly, by the underground system; and, thirdly, by overhead conductors.

As to the first, or storage system, we have a splendid example at Birmingham, which, by the courtesy of the chief engineer, Mr. Dickinson, the author inspected some eighteen months ago, soon after its opening. To his mind it is an ideal system, and it is to be hoped it may some day supersede both the underground and overhead methods; but, unfortunately, there is at present little hope of such a consummation—at any rate, on gradients such as exist in Bradford.

On level routes it is a system even now well worthy of consideration, and although it may be more costly to work than the overhead and conduit systems, yet it has many advantages over its rivals—such as the cars being able to run quite independently of each other, and independently of either overhead or underground wires, thus freeing the streets of many objectionable obstructions. It has many other advantages that need scarcely be recounted to a meeting like this—not the least of which is its freedom from one serious drawback of the direct system, viz. where a breakdown of the principal machinery at the power station causes a temporary stoppage of the entire system.

Unfortunately, there are some disadvantages, the two most serious being the great weight of the batteries, which, at Birmingham, on a comparatively level line, amounts to 4800 lbs., or 2 tons and 3 cwt.; this, added to the weight of car and motor, making 8½ tons for a car carrying fifty passengers.

Another serious disadvantage is the deterioration of the batteries; and although some progress has been made within the last year or two in making the plates more durable and reducing the weight, there is still much room for improvement.

It is therefore necessary to turn to the direct system, where there is the choice of two methods—the underground or conduit system, or that of overhead wires.

It is true there are several ingenious contrivances which may be included under the head of surface methods with electro-magnets attached to the car, but they have scarcely yet passed the experimental stage, and at present are certainly not practicable for hill-climbing.

The underground system, which has been for six years in operation at Blackpool, has proved fairly successful, in spite of the difficulty caused by the sand blowing into the conduit from the shore, and occasional flooding by sea-water during storms, and by exceptionally high tides.

In America this system has made very little progress, partly because of its extra cost, but mainly on account of the difficulty in preventing the conduit becoming filled with mud and water. This rather points to imperfect sewerage systems, and should not apply to a well-drained town, where frequent connections would be made between the conduit and main sewer. An inland town would, of course, be free from sea-water and sand, and so long as the main sewers do not become overcharged during thunderstorms and heavy rains, there is no great reason why the conduit arrangement should not answer. Like the other systems, it is not free from disadvantages, but no doubt its large additional first cost, and the drainage difficulty, have been the chief factors in preventing its adoption to a greater extent in America.

Finally, we come to the overhead system. On this side of the Atlantic there is no doubt a prejudice—or, to put it more mildly, a very strong objection—against allowing posts and wires to be erected in and over our streets; not only on account of disfigurement and obstruction, but also from fear of accident. On the latter score there is evidently little ground for misgiving, seeing that no fatal, or even serious, accident has occurred yet. As regards the disfigurement of the streets caused by the posts, no doubt it is possible to reduce the objection to some extent by using suitable ornamental iron posts; but as obstructions they will, be more apparent in our streets than in some Continental cities, where they are to a great extent hidden by the long avenues of trees which line the edges of the footwalks. In many such cases the poles support lamps for lighting the road by electricity. Personally, either the conduit or over-head systems would be welcomed, if they would deliver us from steam haulage.

With a view of obtaining information as to the cost and capabilities of electricity in propelling tramcars on steep gradients, the Bradford Corporation recently entered into an arrangement with Mr. Holroyd Smith, acting with Messrs. Easton and Anderson, whereby those gentlemen undertook to construct an electric car, and to make trial runs for a few weeks on the Bradford tramways in Cheapside and Manor Row, between Forster Square and the Grammar School, the Corporation supplying the current required during the experiment from the electric lighting station, by means of overhead conductors, at a pressure of 300 volts.

The length of the trial run is 660 yards, commencing with a tolerably level inclination of 1 in 340 for 100 yards, then curving into Cheapside on a gradient of 1 in 13·22 with a radius of 64 feet 6 inches, followed by a straight inclination of 1 in 14·75 for 193 yards, 1 in 20 for 137 yards, and terminating at the end of a comparatively level gradient of 1 in 104 for 160 yards. The total rise is 70½ feet or an average inclination of 1 in 28.

The Wakefield Road route is even steeper than this, having a total rise of 352 feet from the Town Hall to Rooley Lane, a distance of 2830 yards, or an average of 1 in 24.

The experimental running began on the 16th of May and terminated on the 9th of June. The car only ran on 13 days, and made 204 return journeys, or a total mileage, including the triangle at Forster Square, of 157½.

Average time per journey up, 3·79 minutes = 6 miles per hour.

Average time per journey down, 3·73 minutes = 6 miles per hour.

Quickest journey up, when motors were worked in parallel, 2·00 minutes = 11 miles per hour.

Slowest journey up, 5·00 minutes = 4½ miles per hour.

Total measurement of electricity used during the 13 days' run, 240 Board of Trade units.

Average per mile run, 1·52 unit, say 1½.

ELECTRIC TRACTION.

Fig: 1.

DIAGRAM OF MOTORS IN SERIES.

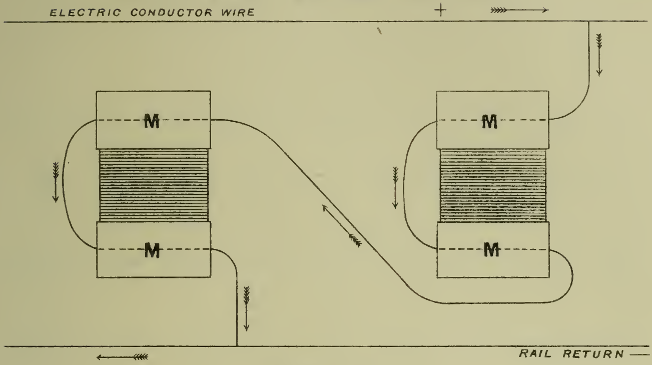


Fig: 2.

MOTORS IN MULTIPLE PARALLEL.

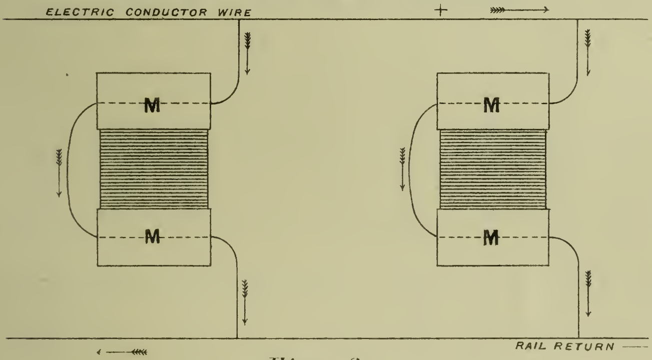
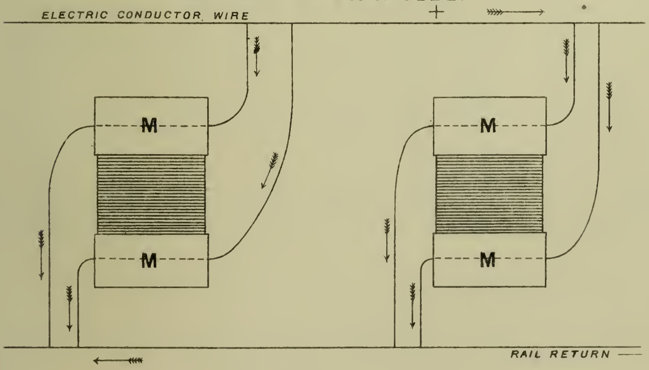


Fig: 3.

MOTORS IN PARALLEL.



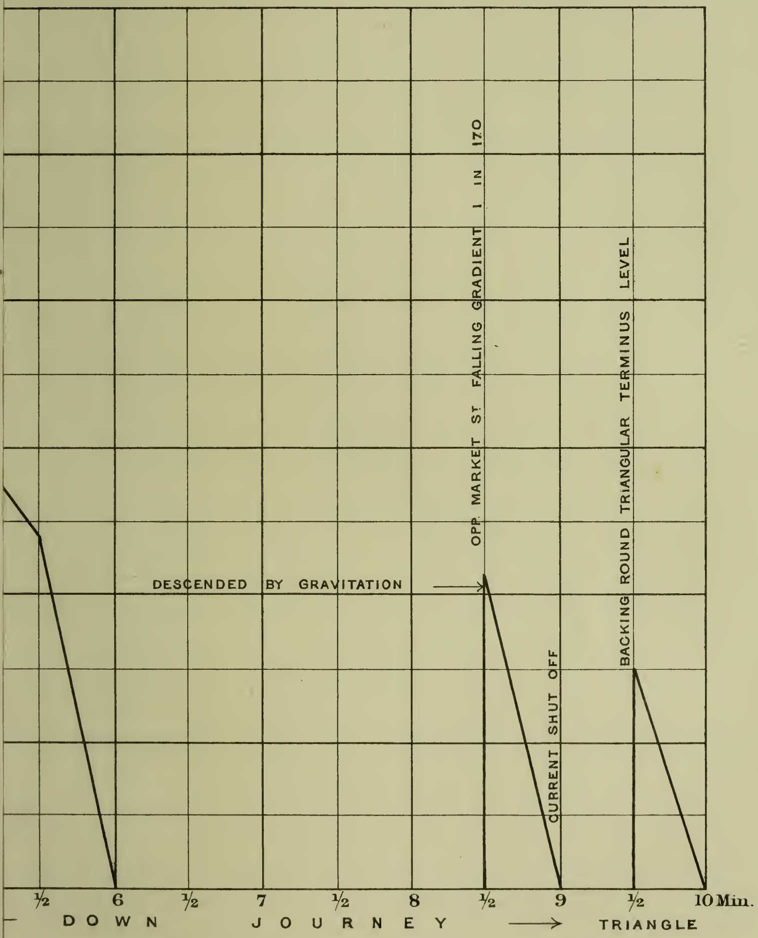
J.H.COX.M.INST.C.E.

Thos Kell & Son, Lith.

TRACTION.

YS. EXPERIMENT IN CHEAPSIDE.

TAKEN AT INTERVALS OF 30 SECONDS.

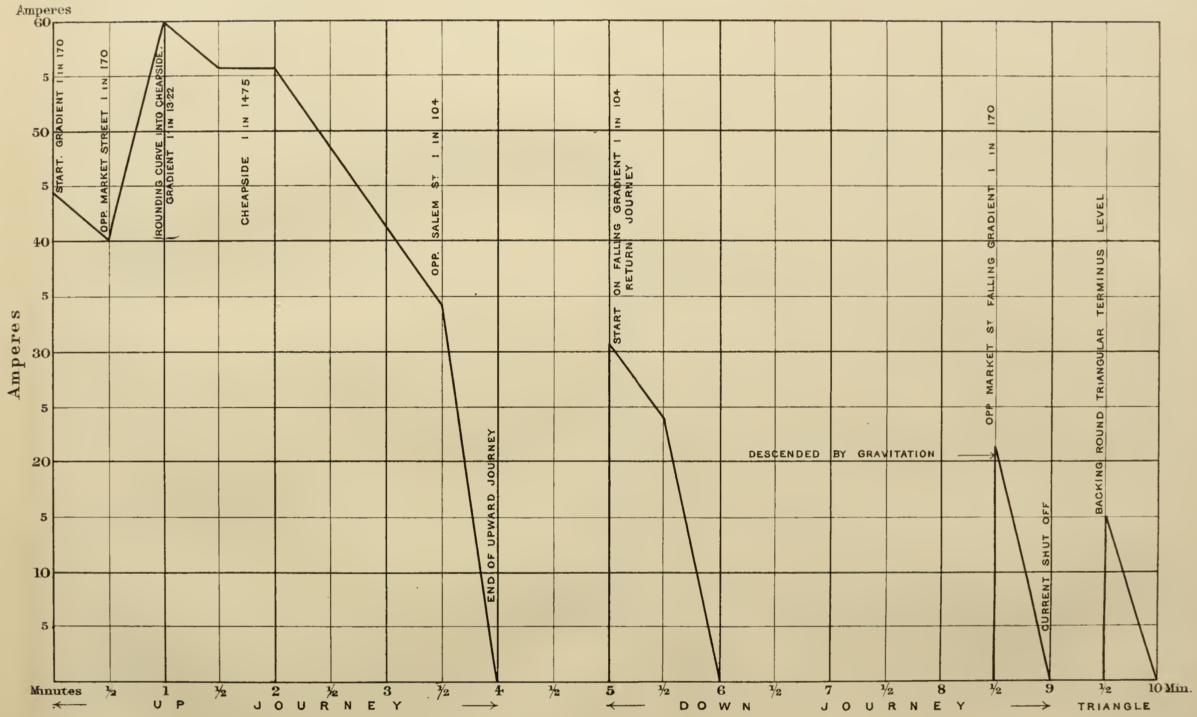


Thos. Kell & Son. Lith.

ELECTRIC TRACTION.

BRADFORD CORPORATION TRAMWAYS. EXPERIMENT IN CHEAPSIDE.

DIAGRAM SHOWING NUMBER OF AMPERES TAKEN AT INTERVALS OF 30 SECONDS.



J.H COX M.INST C.E.

Thos. Kell & Son. Lith.

Therefore, taking an average throughout the entire trial, the car required for its propulsion, 2 E.H.P. hours per mile run.

Cost per mile run for electricity, assuming the price to be 2½*d.* per Board of Trade unit, 3·81 pence.

The price of 2½*d.* has been fixed by the Gas and Electricity Committee of the Bradford Corporation, and the author is of opinion that they could afford to supply the current at 2*d.* per unit, a price which would not only pay for the generation of the electricity, but leave a sufficient margin to cover establishment and other charges. It may be mentioned that only last week a private firm of engineers, having their works situate about half-way on the Wakefield Road route, offered to supply the current at 2*d.* per Board of Trade unit.

It may be as well to explain briefly, for the benefit of those Members who have not given much attention to electrical matters, that a Board of Trade unit is equal to 1000 watts, or one kilowatt supplied for one hour.

This has been fixed by Act of Parliament as the unit of sale of electrical energy, and is based on the international system of electrical measurements universally adopted throughout the world.

Electrical energy consists of the product of two factors—the current measured in amperes, and the electrical pressure measured in volts.

Briefly then the number of volts multiplied by the number of amperes will give the watts, and the watts divided by 746 will give the H.P.

A Board of Trade unit being equal to 1000 watts supplied for one hour, is also equal to about 1⅓ H.P.

The number of passengers carried up was 1321, or 6·4 persons per journey. Passengers carried down, 912, or 4·5 persons per journey. Greatest number of passengers carried up on one journey, 44. Greatest number of passengers carried down on one journey, 38. The driver and conductor are not included in the above figures.

The car has been stopped and started again on the steepest gradients without difficulty, even when fully loaded with passengers, and has taken the curve at the bottom of Cheapside without any preliminary rush.

The E.M.F. has only varied very slightly from about 280 to 300 volts.

On several of the ascending journeys the voltmeter and ammeter carried in the car gave the following readings, at various places on the route, viz:—

	Volts.	Amperes.	E.H.P.	Gradient.
Opposite the end of Market Street	294	40	15·76	1 in 170
Rounding curve into Cheapside	280	60	22·52	1 in 13·22
Half-way up Cheapside	281	56	21·09	1 in 14·75
Opposite Salem Street	281	34	12·80	1 in 85

On the descending journey—

Opposite Savings Bank	294	24	9·45	1 in 104
Rounding triangle, Forster Square	300	15	6·03	level

The momentary current required to start the car on the steep gradient in Cheapside was about 100 amperes.

The car will seat 36 passengers, 18 in and 18 out, and weighs 2 tons 9 cwt. 2 qrs. The motor truck and motors weigh 3 tons 19 cwt. 2 qrs., total say 6½ tons; when fully loaded with passengers the total weight may be taken at 8½ tons.

Dual armature motors of 15 H.P. each transmit motion to the wheels by means of worm gearing, and the worm wheels are so attached that each car wheel is separately driven, each axle having only one wheel keyed upon it, the other being keyed upon a loose sleeve conjointly with a worm wheel.

The electricity is controlled by three switches at each end of the car, one a main supply or emergency switch, one a regulating switch acting upon resistance coils, and one a setting switch whereby the two dual armature motors may be set to work in series, see diagram, Fig. 1, which gives a slow speed of say 4 miles per hour; in multiple parallel, Fig. 2, which gives a moderate speed up-hill of 6 to 7 miles per hour; or in parallel, Fig. 3, a speed of 11 miles per hour.

During the trial, some hitches occurred from various causes, occasioning delay; but nothing really serious happened to raise much doubt as to the ultimate success of the experiment.

The motors at first produced a slight hissing sound, but this was soon remedied, and the running of the motors and gearing afterwards was practically noiseless.

An electric brake is available, so arranged that when the car is running down-hill by gravitation alone it drives the motors, and they can be instantly set to act as dynamos, generating a current that tends to drive them in a reverse direction, and so stop the car.

Although a few mishaps occurred, as above stated, it has been clearly shown that the motors are amply powerful to work steep gradients. The car runs very smoothly, without making much noise or nuisance of any kind, and causes considerably less damage to the permanent way than the heavy steam engines and cars at present in use.

The net results, then, of the recent experiments in electric traction at Bradford show that cars worked by electricity can be made to mount any gradient which can be climbed by a steam engine, and quite as cheaply, providing there is a tolerably quick service and plenty of traffic; that the energy required to ascend and descend such gradients as have been mentioned is 1½ Board of Trade unit per mile, and assuming the price of the electricity to be 2*d.* per unit, it follows that the cost of running up and down such gradients is 3*d.* per car mile.

As the primary object of the experiment was to ascertain the desirability or otherwise of adopting electricity for working the projected steep line in Wakefield Road, perhaps the author may be permitted to state as briefly as possible the conclusions which he arrived at.

The length of the proposed tramway route for Wakefield Road is 2⅛ miles. The carriage-way at present is not sufficiently wide to admit of the construction of a double line, and, if specially widened for the purpose, it would involve the narrowing of the footways to the extent of about 2 feet on each side of the road, at an expenditure of 1600*l.*

A double line of ordinary tramway would cost 4500*l.* more than a single line with passing places, besides an additional cost of 3150*l.* for a double underground conduit.

There are also other advantages in favour of a single line, viz.:—There is less interference with the roadway and ordinary traffic, less length of line to maintain, less rental for the lessees to pay, and experience has proved that the wear of a single line is very little, if any, more than that of a double line. This may appear somewhat strange, seeing that there is twice the amount of traffic passing over the single portions of the line that passes over the double portions; but the joints of a tramway are always the weakest places, and on a double line the heavy engines and cars are constantly travelling in one direction, which tends to beat or hammer down the leading end of each rail, thus causing serious damage both to the rail, fish-plates, and concrete foundation at each joint, whereas on the single line the traffic passing in both directions compensates matters by pressing equally on both rail ends.

Formerly there was some difficulty experienced in working a single line and passing places with the electric and cable systems of traction, but such improvements have been made in the points and crossings, that no serious difficulty need be apprehended in this respect.

The estimates are based on a 15 minutes' service, which gives 80,000 car miles per annum.

WAKEFIELD ROAD TRAMWAY.

Electric Traction:—Approximate Estimate of Working Expenses, at per car mile, in pence.

	d.	
Electrical energy	3·812	per car mile.
Wages of drivers and conductors	2·000	,,
Repairs to motors, &c.	1·000	,,
Repairs to cars	0·200	,,
Depreciation on rolling stock	1·300	,,
Water and gas	0·250	,,
Rates and taxes	0·650	,,
Maintenance of electric conductor	0·345	,,
Compensation for damages	0·250	,,
Stationery	0·070	,,
Salaries	0·858	,,
For 80,000 car miles	10·735	,,

Owing to such a small car mileage as would be attained with the present limited passenger demand, the expenses work out exceedingly high, and it is quite hopeless to expect electric traction paying on a short isolated line like Wakefield Road, unless a much quicker service can be maintained with at least double the above number of car miles annually.

The working expenses, which the author estimates at 10¾*d.* per car mile run, exclusive of rental,* would decrease rapidly in proportion to the number of miles run.

For instance, for another line in Bradford, viz. Manchester Road Tramway, having a yearly car mileage of 175,000, the rate for working expenses and rent would probably be reduced to 9*d.*

Again, the receipts on this line are very high, viz.:—about 16*d.* per mile run, whereas on the Wakefield Road line, they cannot safely be estimated to reach more than 11*d.* or 1*s.* per car mile.

The following statement marked A, gives a summary of the capital expenditure.

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* Conduit system, rental 3·31 pence per car mile additional, viz. 14*d.*
Overhead ,, ,, 2·46 ,, ,, 13¼*d.*

Statement B shows the approximate annual working expenses.

WAKEFIELD ROAD TRAMWAY. A.

Capital Expenditure. Summary.

Description.	Permanent Way.	Electrical Work.	Widening Carriage-way.	Main Supply Cable.	Total.	Equipment by Lessees.
	£	£	£	£	£	£
Double line throughout, overhead conductor	16,200	3,190	1,611	750	21,751	8,900
Single line, overhead conductor	11,700	3,190	nil	750	15,640	8,900
Double line, conduit system	16,200	11,340	1,611	750	29,901	8,900
Single line, conduit system	11,700	8,590	nil	750	21,040	8,900
Steam traction, single line	11,700	nil	nil	nil	11,700	11,850

WAKEFIELD ROAD TRAMWAY. B.

Annual Working Expenses. Summary.

Description.	Annual Working Expenses.	Annual Rental.	Total.	Receipts.	Surplus.	Deficit.	Equipment by Lessees.
	£	£	£	£	£	£	£
Electric overhead conductor	3578	821	4399	4000	..	399	8900
Electric conduit system	3578	1104	4682	4000	..	682	8900

It is therefore certain that electric traction cannot be adopted for the Wakefield Road line so as to be self-supporting, the loss in case of an electric tramway with overhead conductor being 400*l*. per annum, irrespective of the interest on the capital sum of 8900*l*. which would have to be spent by the lessees on the equipment of the line.

This latter sum taken at 5 per cent. would therefore make the total loss 845*l*. per annum.

The loss upon an electric tramway with underground conductor would be still more, owing to the greater first cost of the line. The deficit in this case is estimated at 682*l*., which, added to the interest at 5 per cent. on the sum of 8900*l*. for equipment, gives a total loss per annum of 1127*l*.

Seeing that two tramway companies already exist in the town, both employing steam as a motive power, the most economical course would undoubtedly be to let the line, if possible, to one of them, as the capital charges and working expenses would be considerably reduced in their case, than if leased to a new company or promoters.

The question the author has therefore put to the Corporation is: Will they adopt steam traction for the Wakefield Road section, for the unexpired portion of the lease which has now nearly 11 years to run; in the meantime gaining experience by observing the results of electric traction in other places? or, will they subsidise the tramway to the extent of the loss mentioned, and try electric traction for the remainder of the lease, and thus obtain reliable data, which may enable them to decide as to the motive power to be used on all the Corporation tramways, when the existing leases have expired in 1903?

DISCUSSION.

Mr. LOBLEY: Mr. President, I have very great pleasure in moving a vote of thanks to Mr. Cox for his paper. I think it has come at a very useful period in the history of tramways, and I also think we owe a great debt of gratitude to the Bradford Corporation for leading the way so much as it has done in the matter of electric lighting as well as of electric traction. Mr. Cox says that personally he would welcome either the conduit or the overhead system if they would deliver us from steam traction in the streets. In that remark I concur with very great heartiness. Those of us who have any experience of steam haulage in the streets know the very great annoyance and difficulties connected with it. The water emanating from the engines makes a very disagreeable mess on the roads, the weight of the engines causes great vibration to the rails, and each fish-joint shows a depression in the pavement which, in some cases, is increased by the system of cross sleepers. I am pleased to see that is not the case here, and therefore Bury does not suffer so much as we do. Then there are great complaints of the fumes from the engines.

I am inclined to think that we in England make too much objection to the overhead system of electric conductors. I have recently had an opportunity of travelling over many miles of electric tramways in America. I have visited many cities where the electric cars are used, and the advantages of the overhead system are so great that there is very little chance for many years of anything else taking its place. Take the case of Boston. For some years one company has had the control of all the tramways in Boston. The company has adopted the system of overhead conductors, which they are gradually extending, until now more than half the city is run on that system. No alteration has been made in the line. The line is there with all its old rails and defects. Poles are erected on each side of the street, from which steel wires are carried to support the longitudinal wire over the track. In some cases it runs over grass, which is exceedingly pleasant, but this is only in very wide and straight streets. I have had an opportunity of seeing the working of this system in an old city. My friends were much surprised to hear that Newport, Rhode Island, was an important city long before my own town of Hanley was heard of. They thought that every town in America must be a new town and every town in England an old one. The city of Newport has very narrow streets, not more than 10 or 12 yards wide, and they are not particularly straight; and there the electric system seems to answer very well. The day I was there happened to be a very busy day. It was what we should call a fair or gala, and all the volunteers or militia were gathered in this important watering place. The consequence was that there was a great amount of additional work done by these cars, and they seemed to be very successfully worked. All that had to be done was to hitch one or two more cars on to the ordinary cars, and the electric motor cars drew them in a way which we could not do in England with either horses or steam. The gradients of one in 14 and one in 13½ in Bradford are very heavy, but in the city of Lynn, which I went over, they are one in 10. I went over the works there and the engineer showed me what could be done with these cars. He stopped one of the cars going down a hill, and restarted it backwards again, showing the fullest possible control over the car more than with either horses or steam. This was done on a steep gradient and a sharp curve very unlike the straight streets of New York and Philadelphia. With regard to the supposed ugliness of the overhead wires, I must admit that I was prejudiced against them until I saw them. When some years ago my friend, Mr. Eayrs, said they were going to adopt the system in South Staffordshire, and also Mr. Hewson, in Leeds, I spoke against them. But I had not been in Boston twenty-four hours before I had ceased to notice them, and I think it would be the same here. I do not think I should ever become reconciled to a series of telegraph poles with a score or more wires on each pole, but the overhead conductors are not nearly so objectionable. The great difficulty is at the curves in streets where you require to have a multiplicity of cross wires. The chief advantage of the overhead system is that no expense has to be incurred in altering the existing permanent way. In the conduit system, as in the cable system, it involves the pulling up and reconstruction of the tramway. Then there is the nuisance, which they have experienced in Blackpool, of mud, water, and snow getting into the conduit, and stopping the working of the tramway. The system of storage batteries on the cars, I am afraid, will be a long time coming into general use. To subject the storage batteries to all the concussions of a tramcar is to put a very severe test upon them. I notice Mr. Cox says the total measurement of electricity during the 13 days' run was 240 Board of Trade units. That is a very low figure indeed, and gives us reason to hope there is a future before electric traction even in England. Mr. Cox also speaks of the motors producing a hissing sound. That I certainly found to be the case on many lines in America, but they do not seem to mind noise there—in fact I think they rather like it, for certainly their cars are much more noisy than ours in England. With single line tramways, as in many towns in England, the advantage of electric traction over the cable is very great indeed.

Mr. J. T. Eayrs, Vice-President (West Bromwich) formally seconded the vote of thanks to Mr. Cox for his paper.

Mr. Escott: Might I ask if there is any intention of introducing this system into Bradford. I have had the pleasure of going over the line with Mr. Holroyd Smith, and I was very much struck by the hissing sound from the wires. I think it would be very dangerous for persons to ride on the top of the tramcar, for if any one were to touch the wire with their umbrella or their hand it might be instant death. (Mr. Cox, No, no!) Is not that so? Well, I should have thought it possible. The poles and wires in the streets are like introducing lines upon which to dry clothes. Members have only to go to the road near the infirmary at Leeds to see the effect of the overhead wires. I have never seen the appearance of a street spoiled so much as the street is there, and I hope the overhead system will never be introduced into any town which I have anything to do with.

Mr. **Eachus**: I think Mr. Cox deserves the thanks of this meeting for having put so practical a paper before us and for the moderation with which he has stated the conclusions he has come to with respect to electrical traction. It is very rarely we get a paper which declares in favour of any particular system without a most favourable estimate of the cost. Mr. Cox having come to the conclusion that the Corporation of Bradford must put their hands in their pockets in order to make a reliable test of the economy as well as efficiency of electric traction, has had the courage to state his opinion, and I think by his moderation has done more to further the system than a stronger advocate would have done. The heavy percentage for maintenance and repairs of machinery and plant involved under every other system has forced me to the conclusion that, with our present knowledge, the overhead system is the only one which can be made to pay for general traffic, and I should very much like to see it have a fair trial at Bradford.

Mr. G. F. **Deacon**: My experience of the overhead system—though not in America—has been something like Mr. Lobley's. I had the greatest possible objection to the overhead wires, but having seen the system at work in Italy in the most picturesque parts of the country—the neighbourhood of Florence for instance—I confess that, except at first sight, I should rarely notice the wires. The way in which they are hung is not obtrusive, and the control over the cars is perfect. I would not, however, choose the overhead system if it did not possess great practical advantages.

I am disposed to think that the days of storage cells are numbered. The overhead system is not only cheaper in first cost, but in maintenance also. The hissing sound I think can generally be overcome by attention to the commutators; on the Florence and Fiesole cars there is very little sound. I shall probably not be accused—with my predilection for the beautiful—of wishing to introduce anything that is ugly; but when I see no equally practical way of solving a problem, and when I know that what we think must be ugly proves in practice to be unobtrusive, I give up my opposition to it. After examining the Italian lines I gave up the idea of opposing the overhead system for country or suburban use.

Mr. R. **Godfrey**: I happen to be in the position of having to watch the storage battery system, as the Birmingham Central Company's station is in my district. I am sorry to say I cannot support Mr. Cox in his admiration of the system, because after eighteen months' experience it has not proved such a success as it was thought to be. One of the greatest causes of complaint is the offensive smell of sulphuric acid in the cars. Many passengers have complained of this, and the acid is also dangerous to clothes, particularly affecting the colours of ladies' dresses. Then a fall of 2 or 3 inches of snow stops the running of the cars, which I take it is a fatal objection to the storage system. The waste of energy is also enormous. Where they expected to run ten trips a day they do not run more than four or five.

Mr. W. Jones (Colwyn Bay): Mr. President, I was for some time connected with the Blackpool Corporation and had a good opportunity of seeing the system of electric traction in use there. The power is generated at a central station and it is conducted in conduits laid between the rails. On Clifton Hill, where the gradient is very steep, about one in ten, I have seen the cars stop when part of the way down the hill, and run up to the top again without the slightest difficulty. There was no complaint made as to smells which would be caused by the power being placed on the car. As to snow, we had simply to brush it off the track. We had experience at times of high weather, the water washing on to the cars, but that affected the cars more than the passengers, and the system was a success. Personally I am an advocate of the conduit system for electric traction, and hope that this mode will be ultimately adopted.

The President, before putting the vote of thanks, said: Personally I am very much indebted to Mr. Cox. It was at my request he wrote this paper. You will agree with me that I made a good choice both of the subject and the man. Great credit is due to Mr. Cox for giving us a paper so practical and so deserving of our attention.

Mr. J. H. Cox, in reply to the discussion, said: I am very much obliged to you for your kind reception of my paper. I agree with Mr. Lobley that the prejudice to overhead wires is too strong, and that in time we shall come round to view them with more toleration. With reference to the 240 Board of Trade units for the 13-day run, I should explain that the run was not continuous on the whole of the 13 days: it was intermittent. I should be sorry for you to go away with the impression that the car ran for 13 whole days for 240 Board of Trade units. With regard to Mr. Escott's question whether the Corporation of Bradford are going to adopt this system, that still remains in abeyance. Of course the great loss that is foreshadowed by my report naturally makes them hesitate. We are now waiting for offers from the firm in London which has been carrying out the experiment. We do not expect their offer until next week, but it is certain to be at a loss to the Corporation if electricity be adopted on the Wakefield Road route. It is a very poor district for a tramway, and it is unfortunate that this route has been pitched upon for electric traction, seeing that we have another line where the receipts are 1*s.* 6*d.* per mile run, and we cannot expect to get more than 1*s.* a mile on this one. Then the number of car miles is only 80,000 and it ought to be double that to make it pay. As to the danger of fatal accidents resulting from passengers coming in contact with the wires, I think that can be set aside at once, because although there have been 3000 miles of tramway worked for some years with electricity in America, there has not been a single fatal accident yet, and they work at a much higher voltage than we do. We run at 300 volts and they run up to 500 volts. The hissing is caused undoubtedly by the contact of the brushes with the commutators. That has been remedied, and I do not think we need pay further attention to that objection. I have heard the same complaint as Mr. Godfrey as to the smell of acid at Birmingham, but interviews I have had with the chairman of the line and the engineer, rather led me to think it was not a very serious objection. I have since heard the same complaint from private parties, and I have no doubt there is something in it. In North London, however, where storage batteries are used, there has been no complaint. That objection could not however apply to Blackpool, where a different system is in use, but I am rather doubtful of the existence of any gradient of one in ten on that line. I believe the line at Blackpool is very successful both financially and in other respects. I am afraid my paper is not of general interest to all the members of the Association, but I am so convinced that electricity will play an important part in future with regard to steel tramways that I think it needs no apology for introducing the paper on an occasion like the present. I am very much obliged to you for your courteous attention.

NOTES ON THE FACTORY AND WORKSHOP ACT, 1891, 54 AND 55 VIC. CAP. 75.

BY H. PERCY BOULNOIS, M. INST. C.E., &c., &c., &c.,
CITY ENGINEER OF LIVERPOOL.

THIS Act, which came into force on the 1st of January of this year, constitutes an important addition to the duties of municipal engineers and surveyors and of inspectors of nuisances throughout the country. The Act is chiefly an amendment of the Factory and Workshop Act, 1878, which is operative throughout the United Kingdom, and is much larger in its scope for the purpose with which it deals than the Public Health Act, 1875, which does not extend to Scotland or Ireland, nor generally to the Metropolis. The new Act is to be administered partly by the inspectors of factories, and partly by the sanitary authorities, the latter expression including both urban and rural sanitary authorities, and also district boards or vestries in the metropolis having like powers, the only exception to this being under Section 4 of the Act, which deals with the "cleanliness and whitewashing of workshops," where by Sub-section 4 it is stated that it does not apply to any "workshop" or "workplace" to which the Public Health (London) Act 1891, applies.

Under the Public Health Act, 1875, and the Factory and Workshop Act, 1878, local authorities are now charged with the duty of seeing that workshops generally (including workshops distinct from factories by the Factory Act, 1878, Section 93) are kept in a healthy condition as regards cleanliness, ventilation, and overcrowding. Local authorities are also required to ensure that every workshop under the Factory Act, 1878, and every "workplace" within the meaning of the Public Health Act, 1875, is kept free from effluvia arising from drains, closets, urinals, or other similar nuisances. Further powers are conferred upon the local authority by the new Act with reference to the necessary lime-whitening of workshops, as well as the right of entry and inspection, and taking legal proceedings. These powers of entry, &c.,

are additional to those which the local authorities possess under the Public Health Act, 1875.

Briefly, it may be said that as regards conditions of health, the control of workshops is now handed over from the inspectors of factories to the sanitary authorities.

With regard, however, to both factories and workshops, an inspector of factories may prompt the sanitary authority to enforce the ordinary provisions of the law as to public health, and in default of their doing so he may take proceedings himself, or he may enforce the sanitary provisions without notice to the sanitary authority in cases where he is specially authorised for the time by a Secretary of State. In any of the cases where the proceedings are successful he may recover all expenses from the sanitary authority.

These summary powers as to factories and workshops apply also to laundries, which are now brought under the Factory Acts for the first time.

The most important feature, however, of the new Act, so far as this Association is concerned, is the requirement as to "means of escape from factories in case of fire," contained in Section 7 of the Act. That section provides in effect that every new factory in which more than forty persons are employed shall have a certificate from the sanitary authority that it is provided with a "reasonable means of escape in case of fire," and that it shall be the duty of the authority to examine every such factory and to give a certificate when satisfied that the required means of escape have been provided.

With regard to the factories existing at the time of the commencement of this Act where more than forty persons are employed, the same section provides that it shall be the duty of the sanitary authority to ascertain whether all such factories are furnished with means of escape, and in the case of any factory not so provided, to serve on the owner a notice specifying what is necessary for that purpose and requiring him to carry out the work in a certain time. The principal points to be considered with reference to this section are:—

(1) *Who is the "Owner"?*

(2) *What is a "Factory"?*

(3) *Does the number of forty persons employed relate to the "entire factory," or only to that portion of it which requires "means of escape"?*

(4) *Are the "means of escape" to be special in addition to the ordinary exits?*

The first point as to *Who is the "Owner"?* is fairly well answered in the section itself. In Sub-section (2) he is described as the person being within the meaning of the Public Health Act, 1875, the owner of the factory. The well-known definition in Section 4 of the Public Health Act is sufficiently clear, as it states in effect that the owner is the person who receives, or who would receive the rack-rent.

(2) *What is a Factory?*

This can only be answered by reference to the Factory and Workshop Act, 1878, that being the principal Act to which the Factory and Workshop Act, 1891, is supplementary. Section 93 of the former Act contains a definition of "factory," which is long and intricate, and refers to Schedule 4 of the Act, which is equally long and intricate. It is hardly possible to abbreviate that definition and to obtain precision in the explanation, and the author has therefore added an epitome (Appendix A) of the sections of the Act which attempt to define "What is a factory"?

It may be stated, however, in general terms, and subject to some extensions and limitations of meaning, that a factory is a place where

(*a*) Mechanical power is used to work machinery in manufactures, or where

(*b*) Hand labour is employed in manufactures with mechanical power in aid.

(3) *Does the number of forty persons employed relate to the entire factory, or only to that portion of it which requires means of escape?*

On reference to the section it will be seen that the following words are used: "Every factory . . . . . . in which more than forty persons are employed shall be provided on the storeys above the ground floor with . . . . means of escape in case of fire for the persons employed therein," &c.

It would seem, therefore, to follow, that in the case of a factory where say forty-five persons are employed, of which number only five are employed on the storeys above the ground floor, means of escape must be provided for the use of the five.

It does not seem that it would be sufficient for the owner to contend that there are not more than forty persons employed above the ground floor, or that to require provision perhaps of a costly nature for their safety is unreasonable. If more than forty persons are employed in the entire factory, means of escape must be provided for those persons (if any) however few, who are employed above the ground storey.

On the other hand it seems clear that there is no power to require means of escape from the ground storey, or from storeys below the ground storey, although there are cases where such storeys are specially liable to fire, and where the means of escape are inadequate, however many persons may be engaged at work in these storeys.

This appears to be a defect in the framing of the Act, but one which may not have been thought to be of sufficient importance to be dealt with. There is, however, a further defect of some importance which apparently might well have been met by special provision. It is as follows:—the author has already pointed out that five or even a less number of persons, working in an upper storey must be provided with sufficient means of escape in case of fire when more than forty persons are employed in the entire factory, but in cases where twenty, thirty, or even forty (not more than forty) workpeople are altogether in upper storeys, the factory being situated entirely above the ground floor, the enactment does not apply. Such cases are not at all rare, especially in towns where the ground storeys are occupied for shop purposes, often at high rentals, and the upper storeys are used as factories. In every such instance the unfortunate persons in the factory at the top of the building (provided they do not exceed forty persons) receive no protection from the new Act, although in another factory a much lesser number of persons in the upper storeys may receive adequate protection.

(4) *Are the means of escape to be special in addition to the ordinary exits?*

The section prescribes that the means of escape in case of fire shall be furnished on the storeys above the ground floor. The means of escape also are to be such as can reasonably be required under the circumstances of each case.

It may, therefore, be fairly argued that in some cases the ordinary exits already provided from the upper storeys would not be quite reasonably sufficient and yet may be capable of improvement so as to be better adapted for the purpose than any additional exit or exits could be made. Thus, a building of several storeys in height above the ground having one long front to an open workyard, and practically no other front, may have a fireproof staircase external to the workrooms, placed in the middle of the front. Such a staircase may be the best kind of arrangement possible under the circumstances, and yet it may not be adequate for the egress of a large number of persons in a state of panic. In such a case it might be possible to improve the staircase sufficiently by widening the several doorways in it, or by altering the arrangement of the steps or landings, or by enlarging or inserting windows in it, so as to give the workpeople a better view of the open yard, and better means of escaping by the staircase.

In such an instance the means of escape which could be "reasonably required" might not involve the provision of additional exits.

Another instance may be that a staircase (even a fireproof staircase) is placed within the building, with its foot in the ground storey at some distance from the outer walls. The various storeys (including the ground storey) may be liable to fire, and the workpeople in the upper storeys may run the risk of being suffocated in this staircase, or being burnt in the ground storey before they could reach the outer air.

In an arrangement of that kind the means of escape which could be "reasonably required" would involve the provision of additional exits. It may, therefore, be concluded that the question, whether the means of escape are to be in addition to the ordinary exits, can only be answered with reference to the "circumstances of each case" taken by itself.

Here we arrive at the main point in the administration of the Act as to "What is the best method of providing the required means of escape in the generality of cases?" We cannot take this to mean the "ideally" best method, or the best possible method of providing means of escape. The sanitary authority must be satisfied with such means of escape as can "reasonably be required." It would not be unreasonable in most cases to require that the persons employed in the building shall be able to readily escape from the room, where fire has broken out, into the open air at some level or other. This at least would prevent suffocation and would allay panic. The best and easiest way of effecting this object would usually be to provide a strong balcony, or flat roof (perhaps of concrete), at, or near the level of the floor of the particular storey in question; the balcony to be continuous throughout the length of the outer wall on which it is fixed, not a mere balconette in front of each window. If possible it would be a good arrangement to connect one or both ends of the balcony with a flat roof of a lower building. Egress from the workroom, or balcony, or flat, as the case may be, should be direct, and as easy as possible. It would be better that there should be no necessity to climb up on to a window sill at a height of 3 feet or 4 feet above the level of the floor of the workroom, but a sufficient doorway should be provided in the usual way.

The balcony should have a strong railing, about 4 feet in height.

The persons in danger having escaped for the moment from the immediate presence of fire, some means of descent to the ground is necessary. To meet this need several patent arrangements of folding ladders, or other apparatus, would be suggested for adoption, but it may be presumed that most responsible officials of sanitary authorities would not be content to allow that such precarious means of escape are reasonably sufficient.

In some cases the balcony, or flat, may be connected with another building in the same occupation where there is no risk of fire, and where sufficient and easy means of egress may be had. But if descent from the balcony, or flat, can only be had by providing a fixed stair, or step-ladder, communicating with another balcony or flat at a lower level, it will, in the author opinion, be "quite reasonable" to require such a provision, even if the stair has to be fixed on the outer face of a wall abutting on a public street. In that case it would be sufficient to make the stair, or step-way, wide enough for only one person to pass down at a time, and it may not be necessary to continue it to the level of the ground.

The character of the balcony is a matter of some importance. A projection of 2 feet 6 inches from the wall would be sufficient, and the width of any stair or step-ladder may be as little as 18 inches in the clear. This will allow a space of one foot between the railing of the balcony and the rail at the head of the stair, when the latter is placed close to the wall as it should be. If possible, the whole of the balconies and ladders should be of wrought iron, not of cast-iron, which is treacherous even when first erected and rapidly deteriorates by rust.

As the persons who are affected by the new Act may be inclined to regard it as a somewhat unnecessary interference with their rights, it is as well to approach them in the first place in as considerate a manner as possible. Thus, it is well to issue a preliminary notice informing the owners and occupiers of the fact that a new enactment has come into force, which the local authority is bound to carry out, and the author has appended to this paper a specimen form of notice (see Appendix B).

In connection with the issuing of this notice the author has found difficulty, and has had many courteous replies thereto. Another good effect of the preliminary notice is that sometimes the occupier will write to say that the number of persons employed is less than forty, and the responsibility thus rests with him, if he has given wrong information. After making a sufficient inspection (which in many instances will require more than one visit), if the surveyor is convinced that sufficient means of escape have not been provided, he will find that the next proper step is to report the facts briefly to the local authority, in order that they may instruct either their surveyor or clerk to issue a legal notice to the owners. This will necessarily be a strictly legal notice in which there will be no place for expressions of mere courtesy, and a specimen form is hereto attached (see Appendix C). It must specify the requirements of the authority for the purpose of carrying out the objects of the section, and will require careful consideration on the part of the surveyor in making his report to the authority, and the literal wording of his report should be followed as far as possible in the wording of the legal notice. The information given must be sufficient to enable the owner to hand it on to an architect or builder, who would thus be able to plan and execute the work. In this notice a date must be specified before which the measures necessary for providing the required means of escape must be carried out. The time should be sufficiently long to allow of the alterations being schemed and effected without undue haste, and during the course of the time specified it will naturally be prudent to inquire whether steps are being taken to comply with the notice, and in case of neglect to warn the owner that proceedings will follow after the term has expired if the neglect is continued.

One of the most important practical points in the administration of this part of the Act is the granting of a certificate as to the sufficiency of the means of escape from "factories" erected after the commencement of the Act. It will perhaps be best to make this document as brief and general in its terms as possible. It may be confined to a simple statement that the means of escape are sufficient and reasonable under the circumstances of the case, following closely the words of the Act. A specimen form (see Appendix D) is annexed.

There is a somewhat remarkable omission from the section of any requirement of inspecting factories from time to time after the first inspection has been made to ascertain whether they are provided with the means of escape mentioned in the Act for factories which are commenced to be erected after 1891. For those factories existing at the commencement of the Act provision is made for re-inspection. It is somewhat curious also to note that no certificate is required to be granted in the case of factories existing or begun to be erected before the commencement of the Act.

The foregoing remarks as to notices and reports and the methods of improving the means of escape obviously relate to these existing factories. These are the buildings that will give most trouble to the surveyor. But although the powers of the Act with regard to them are both comprehensive and strong, there is no obligation to grant a certificate. It is only with respect to new factories (i. e. those begun to be erected after the commencement of the Act) that a certificate is to be granted.

The reason for this difference of treatment is not quite apparent, although there may have been good reasons in the minds of the framers of the Act. It would seem to follow that the granting of a certificate for an old factory would be *ultra vires*, and might be productive of more harm than good. Another puzzling anomally of rather greater importance appears in the strange circumstance that whilst the authority must grant a certificate for every new factory provided with sufficient means of escape, there does not seem to be any provision for making a renewed inspection of the building, or granting a renewed or amended certificate, or cancelling the original certificate, in the case of additions or alterations to the building.

It is quite possible that the condition of things in the buildings may be so changed, in course of time, that the certificate may become untrue and worthless. But the powers of the local authority will have been exhausted, and so the object of the section will be defeated, at least with regard to new factories. This defect will probably be found to be a serious one requiring amendment, and it might be well for this Association to draw the attention of the Board of Trade to this serious omission.

APPENDIX A.

Factory and Workshop Act, 1878.

Section 93 of principal Act, and Schedule 4 of same Act, defines "Factory," from which it appears that —

"Factory" includes "textile factory" and "non-textile factory."

"Textile factory" means premises where mechanical power is used to work machinery in the manufacture of fibrous material, *except* rope-works, hat-works, &c.

"Non-textile factory" means (amongst other places),

Foundries of any kind,
Lucifer-match works,
Metal works, where mechanical power is used in manufacture of machinery or any article of metal,
India-rubber works, where mechanical power is used in manufacture of india-rubber, &c., or articles of ditto,
Tobacco factories,
Letterpress printing works,
Book-binding works ;

also any of the following places where mechanical power is used in aid of the process carried on—

Hat works,
Rope works,
Bake-houses for bread, biscuits, or confectionery,
Shipbuilding yards;

and, generally,

any place where hand labour is employed, *with mechanical power in aid*, for making, ornamenting, or finishing any articles of trade.

APPENDIX B.

(Preliminary Notice).

Factory and Workshop Act, 1891 (54 *and* 55 *Vict. cap.* 75).

City Surveyor's Office,

________________189____.

*To*________________________________

____

The above named Act having come into force on the 1st January, 1892, I beg to call your attention to Section 7 of the Act, which relates to the provision of means of escape from " Factories " in case of fire.

It is now the duty of the Corporation of____________to see that, within the City, every " factory " in which more than forty persons are employed is furnished with reasonable means of escape therefrom in case of fire.

It is believed that the building in________________________ Street, of which you are the____________________is a " factory " within the meaning of the Act, and that more than forty persons are employed in it.

I therefore beg to give you notice of my intention to cause an inspection of the said building to be made as soon as may be convenient, with a view to determining whether sufficient means of escape have been provided, and, if not, what further provision may reasonably be required to be made. In the latter case, a formal notice to that effect will be served on________________ in due course.

The cost of any alteration of or addition to the building falls upon the owner, unless a County Court order is obtained requiring the occupier to bear or contribute to the expenses.

I am,

Yours faithfully,

____

City Surveyor.

APPENDIX C.

The Factory and Workshop Act, 1891.

TOWN CLERK'S OFFICE,
____________________.

To ______________________________

____

By the direction of the Mayor, Aldermen, and Citizens of the City of__________, being the Sanitary Authority under The Factory and Workshop Act, 1891, for the said City, **I do hereby give you notice** that the Building situate and being______________________________

____

____

within the said City, of which you are the Owner within the meaning of the Public Health Act, 1875, is a "Factory" within the meaning of the Factory and Workshop Act, 1891, in which more than forty persons are employed, and is not provided on the storeys above the ground floor with such means of escape in case of Fire for the persons employed therein as can reasonably be required under the circumstances of the case.

And I further hereby give you notice that, in order to provide such means of escape as aforesaid, the following measures are necessary, namely:—

____

____

____

____

____

and you are hereby required to carry out the same before the____________ day of____________________next.

I also hereby give you further notice that unless the above requirements are complied with, you will be liable to a Fine not exceeding One Pound for every day that such non-compliance continues.

Dated this__________________day of__________________________ one thousand eight hundred and ninety-_____.

____

TOWN CLERK,

And Clerk to the Sanitary Authority.

Inquiries may be made at the City Surveyor's Office.

MEMORANDA TO BE PUT ON THE BACK OF THE NOTICE (SEE APPENDIX C).

The notice of which this is a true copy was served upon ____________________ personally (or) by delivering the same to ____________________ (or) by sending the same through the Post in a Registered Letter addressed

____

on the ____________ day of ____________ 189 __

by me ____________________

____

____

____

____

____

____

Summons issued on the ____________ day of ____________ 189__.

Summons heard on the ____________ day of ____________ 189__.

by ____________________

Notice complied with ____________ 189__.

____

District Building Surveyor.

APPENDIX D.

The Factory and Workshop Act, 1891.

Certificate.

TOWN CLERK'S OFFICE.

__________________.

*To*______________________________

____

By the direction of the Mayor, Aldermen, and Citizens of________ being the sanitary authority under the Factory and Workshop Act, 1891, for the said________, **I do hereby certify** that the building situate and being

____

within the said ______, of which you are the owner within the meaning of the Public Health Act, 1875, and being a "Factory" within the meaning of the Factory and Workshop Act, 1891, of which the construction was commenced after the First day of January, 1892, and in which more than forty persons are employed, **is provided** on the storeys above the ground floor with such means of escape in case of fire for the persons employed therein as can reasonably be required under the circumstances of the case.

Dated this ____________day of__________________one thousand eight hundred and ninety ______.

____

TOWN CLERK,

And Clerk to the Sanitary Authority.

DISCUSSION.

The **President**: Gentlemen, we have had from Mr. Boulnois a very valuable and practical paper, and one that will save a great deal of trouble to many of us. It is a clear and concise exposition of an Act of Parliament which is now in force, but, which, I am afraid, many of us are ignoring, and so far may be said to be neglecting our duties. I trust that the Legislature have acted wisely in what they have done for the benefit of the workpeople. I have pleasure in moving, not merely as a formal matter from the chair, but with all sincerity, a vote of thanks to Mr. Boulnois for his valuable paper.

Mr. **Stead** (Harrogate): I have very great pleasure, Mr. President, in seconding the vote of thanks.

The vote of thanks having been accorded with acclamation,

Mr. H. **Percy Boulnois**, in reply, said: Mr. President, I must tender my apologies for not being here yesterday. It was a cause of great regret to me that I was not able to be present; but as you know, the Annual Meeting, which is usually held in June, was postponed, and this made it very difficult for me to attend. With regard to my paper, I should like to make it clear to all the members (some of them having spoken to me about it) that this new Act only applies to factories, not to workshops. It is a very curious thing, why the Legislature have not applied the Act to workshops, but it only applies to factories. I thank you very much for the way in which you have received the paper.

SEWAGE AND ITS PURIFICATION.

By CHARLES A. BURGHARDT, Ph.D., &c.,

Lecturer and Examiner in the Victoria University,
Manchester, Analytical and Consulting Chemist.

It is unnecessary to apologise for bringing this old subject before you, because the author is sure that many here have been often engaged considering how best to solve the difficult problem of sewage treatment under the peculiar conditions obtaining in their district, and any further information which can be gained, however slight, will be of some assistance in arriving at the best treatment to be adopted under the circumstances. Sewage is a very complex substance, chemically speaking, and can be divided into two distinct classes:—

1. *Domestic sewage*, which is mostly animal in its origin, and much charged with nitrogenous and carbonaceous matters which are more or less easily decomposed by so-called secondary decomposition, induced principally by the oxidising action of the oxygen of the air. The nitrogenous matters consist of urea, uric acid, colouring matters of animal origin, mucus, and various bodies in a state of unstable equilibrium, somewhat resembling albumen in their chemical characteristics, and called generally, for the want of a better term, "albuminoid matter."

2. *Manufacturers' sewage*, or the waste waters from all kinds of chemical works, dye works, bleach works, paper mills, &c. As a rule this class of sewage is not rich in nitrogenous matters, but it is generally rich in carbonaceous matters, both in solution and suspension, and highly charged with various salts in solution. The substances in this class of sewage are more stable than those present in domestic sewage, consequently they are not so easily decomposed or oxidised, and their presence in a mixed sewage is therefore highly objectionable, because they actually prevent to a very great extent the oxidation and destruction of the domestic sewage, and act as a "resist" to the oxygen of the air.

From this generalisation of sewage it is clear that Lancashire men have, unfortunately, the very best opportunities for thoroughly studying the question of its treatment, for they can certainly claim to turn out the most complex and abominable mixtures of sewage into our streams which it is possible to produce. Every possible variety of sewage is represented, and the investigator has all the material necessary for his inquiry at his own door. In a manufacturing district, therefore, the sewage of towns and townships consists of a mixture of the two above-mentioned classes of sewage, and it is constantly varying in composition, no two consecutive hours being alike. For this reason it is almost imperative that such sewage should be treated specially, with regard to the particular district from which it arises, it being scarcely possible to lay down one uniform method of treatment which will successfully meet all cases.

Some years ago the author pointed out the immense importance of removing sewage of both classes from our streams, for this reason, viz.: if it were not removed, and pollution continued on the same scale, then it was quite certain that a time would come when Lancashire streams would be so foul that no manufactures requiring clean water could be further carried on, and such manufactures and processes would be strangled by their own act, and the trade transferred to some other locality or country where such a disgraceful state of affairs did not exist. This was in 1884, and we now see in 1892 already signs that this opinion was well founded. The author will deal with this subject of river pollution after dealing with that of sewage treatment, at the end of this paper.

With regard to the treatment of sewage, it may be said that there are, broadly speaking, three general methods or systems adopted in this country, viz. —

1. Irrigation and sewage farming.
2. Intermittent downward filtration.
3. Precipitation by chemicals, with or without subsequent intermittent downward filtration.

With regard to the first method, it has been known for a long time that on the whole it has proved to be a costly, and, one may also say a ghastly failure. It is only in a very few highly favoured districts where such a system can be successfully carried out, so far as the purification of the raw sewage is concerned, and in all these cases there still remains the undeniable fact that, from our present knowledge of the spread of disease by means of micro-organisms, the covering of large areas of land with a deposit of sewage sludge or mud is a constant menace to the health of the people living in the neighbourhood of such areas. As the mud dries, the micro-organisms (some of which may be highly septic) are spread by the wind far and wide, and find a congenial home in the bodies of the unfortunate population whose constitutions have been previously much impaired by the foul exhalations which rise (particularly in summer evenings) from such sewage farms. It is only possible to produce a suitable effluent from raw sewage by irrigation when there is a sufficient depth of porous soil as a filtering medium, and, further, a large enough area to allow of a change of top soil from time to time, by ploughing or other means. If these conditions cannot be complied with, sewage irrigation becomes absolutely impossible, on account of the choking up of the surface of the land by the "sewage-slime." Looking at this branch of the subject from another point of view, it is an outrage upon all natural laws. Plant life takes up its nourishment from manures, either liquid or solid, in very small quantities at a time, and only at certain seasons. At other times the presence of such manure would be absolutely useless to the plant, and probably detrimental to its progress. From this it is evident that plant life on a sewage irrigation farm must be in anything but a really healthy condition; if the work of sewage purification is to be carried out day and night for the whole year, for many a time when it ought to have rest the plant would be deluged with sewage matter which it cannot assimilate, or at other times when it really wants support it cannot obtain it because the surface of the ground being completely choked with sewage-slime, the roots of the plant are deprived of the necessary aeration on the one hand and sun's action on the other. Further, in deep winter, when the ground is frozen hard, the raw-sewage cannot be purified at all, and is generally discharged in that condition into the nearest stream. The same thing occurs in summer in some places where hay is a crop grown on the farm, no raw or even settled sewage being allowed on the hay-grass for some considerable time, and consequently the crude sewage passes unpurified into the nearest stream as a matter of course. The author has had personal experience of this partial treatment on many occasions, and in all, a fearful nuisance was created by the discharge of this crude sewage into brooks which were otherwise clean, and injunctions were obtained by property owners on these streams against the local authorities who were the offenders. There cannot be any doubt therefore that simple treatment of sewage by passage over land, either good or bad, is quite unsuitable and dangerous to the health of the community. Even sewage irrigation supplemented or preceded by settlement of some of the suspended matters is also a proved failure, as all the objections cited above are equally applicable to this modification. Many local authorities have adopted this or some similar treatment on account of its so-called cheapness, but they will shortly be made aware by the county councils that their disgusting effluents cannot any longer be tolerated in our streams, therefore they must eventually adopt an entirely different treatment of their sewage if they wish to avoid unpleasant consequences.

Now as to the second method of treatment, "intermittent downward filtration." Where this process is carried out upon crude nutreated sewage, the author has no hesitation in saying that it must result in failure, for the same reasons given above that irrigation is a failure, and local authorities will certainly be compelled to modify and supplement their sewage treatment where simply intermittent downward filtration is adopted. For large towns in populous manufacturing districts such a plan of sewage treatment is quite impossible, on account of the enormous area of land which would have to be acquired for the purpose, it being understood that not more than the sewage from about 400 people should be drained upon one acre of good filtering land. Some authorities go as high as 1000 of population to one acre of the very best filtering land and as low as 250 of population to one acre of bad filtering land. It is quite impossible to filter the sewage from a population of 1000 upon an acre of the very best filtering land, and also 250 or even 100 of population upon an acre of bad filtering land. Bad filtering land ought not to be applied to such a purpose under any circumstances whatever.

It is unnecessary to go into this part of the question any further, because every one who has had any experience at all in sewage treatment has long been of opinion that filtration of raw sewage without a previous purifying treatment is obsolete. It will be seen later on that purified or treated sewage, if passed over suitable land or filters of sufficient area, gives an excellent filtered effluent which is quite fit to turn into any stream. Before considering some of the various chemical or "precipitation processes" it will be more convenient to briefly describe the general chemical alteration which domestic sewage undergoes when mixed with water, for water-borne sewage is now the rule and not the exception, therefore those places where the dry earth or the pail systems are adopted being few and far between, such methods of treatment need not be considered in a paper on sewage treatment.

Domestic sewage contains nitrogenous and carbonaceous bodies both in solution and in suspension, those present in the latter being fæcal and most objectionable in character, although not more dangerous from a sanitary point of view than the dissolved nitrogenous and carbonaceous matters. In this sewage matter (principally that in solution) there are sulphates of the alkalies and alkaline earths, calcium phosphate, and the so-called albuminoid matters. The great decomposers are in reality numerous species of micro-organisms of all classes, micrococci, bacteria, bacilli, &c., which split up the above-mentioned albuminoid and carbonaceous bodies into simpler bodies, the final results of their activity being ammonia, obtained principally from the albuminoid matter; carbonic acid gas, obtained by the oxidation of the carbon of the various matters, both albuminoid and carbonaceous; sulphuretted hydrogen, obtained by the reduction of the sulphates mentioned above, by the liberation of nascent or atomic carbon and its immediate recombination with the oxygen of the sulphates themselves, resulting in the production in the first stage of carbonic acid gas or carbon dioxide and calcium, potassium, or sodium sulphide; according to the following chemical equations:—

$$\begin{gathered} CaSO_4 + 2C = CaS + 2CO_2 \\ K_2SO_4 + 2C = K_2S + 2CO_2 \\ Na_2SO_4 + 2C = Na_2S + 2CO_2. \end{gathered}$$

Now we do not find in sewage which is freely acted upon by the oxygen of the air, any sulphides of the alkalies or alkaline earths, but we always do find a considerable quantity of a black insoluble precipitate or deposit at the bottom of a tank or brook in which sewage has been exposed for some days to the air, and on analysis we find that this black substance is a sulphide of iron. How does it get there? As an excess of carbonaceous matter is always present in domestic sewage, the action of the micro-organisms produces from it (assisted by the oxygen of the air) a large quantity of carbon dioxide, which largely dissolves and is retained by the water, in fact decomposed sewage is saturated with dissolved carbon dioxide. This carbon dioxide dissolved in the water now attacks the above-mentioned sulphides and converts them into carbonates, liberating at the same time sulphuretted hydrogen gas, some of which is liberated from the water in the form of bubbles, which soon make their presence evident by their very characteristic smell, whilst another portion of the sulphuretted hydrogen combines with any suitable iron compound in its immediate neighbourhood which may be present in solution, or failing that, suspended hydrated ferric oxide derived from various sources, which is generally present in the beds of most brooks or rivers. In any case this black sulphide of iron is produced and carbonates of the alkalies and alkaline earths are also produced. This production of these carbonates from the sulphides constitutes the second stage of the reaction mentioned above, and it takes place according to the following chemical equation, viz. :—

$$\begin{gathered} CaS + CO_2 + H_2O = CaCO_3 + H_2S \\ K_2S + CO_2 + H_2O = K_2CO_3 + H_2S \\ Na_2S + CO_2 + H_2O = Na_2CO_3 + H_2S. \end{gathered}$$

This then is what occurs when sewage is freely exposed to the action of the air. When the air is wholly or partially excluded, the reaction is somewhat different, the production of carbonates being much smaller in amount, whilst the ammonia produced from the albuminoid bodies mostly combines with the sulphuretted hydrogen (which in any case is always present in more or less amount in decomposing sewage, even when free oxygen is almost absent), forming a solution of ammonium sulphide, a most foul smelling and dangerous compound. This substance has been produced very largely upon filter beds, which have become completely choked and would not any longer allow the passage of water through the filtering medium, the stagnant sewage lying upon the beds to the depth of about 2 feet. It was this depth of liquid which caused the mischief. Oxidation could only take place upon the surface, and the bulk of the liquid gradually became strongly charged with ammonium sulphide. On exposure to air ammonium sulphide rapidly decomposes into free ammonia, water, and free sulphur, the latter making its presence evident by forming a film of sulphur upon the surface of the sewage.

The micro-organisms continue their useful work and increase enormously in number until the unoxidised carbonaceous matter is oxidised as much as it can be, and until all the albuminoid bodies are decomposed and resolved into less complex bodies. When the process is complete most of these organisms die; in fact, there is no doubt that some of the products of their activity are poisonous to them, and perhaps also to mankind. Albuminous bodies which undergo a similar decomposition produce highly poisonous products sometimes, to which the name ptomaines has been given; these ptomaines are found in decomposing flesh, &c., and closely resemble, both chemically and physiologically, some of the well-known alkaloid poisons. In addition to the above-mentioned decomposition products there are two substances always present at the end of the process, not definite chemical compounds, but still chemically speaking always similar in their characteristics. One of these substances is insoluble in water, gum-like in character when concentrated, but flocculent when in oxidised sewage. This insoluble gum-like body is a product of the oxidation of the albuminous and carbonaceous bodies in the original sewage, and is the substance which is most detrimental to the action of a filter, because it chokes up the pores owing to its slimy consistency. The second substance which is present in decomposed oxidised sewage, is soluble in water, gum-like in character, and not further oxidisable except by strong chemical oxidisers, and only then in a very partial manner; it is quite harmless in water. From the above-mentioned facts it is evident that micro-organisms are not altogether objectionable in character. They perform a good work for us, and assist us largely in sewage purification. They certainly take a long time to carry out their operations, but this seems to point out a direction in which to work, namely, to utilise these countless organisms as purifiers of the final effluent from the sewage treatment. Treat the sewage by the best and most convenient process first, and then leave these organisms to complete the work of purification in their own way.

The decomposition of raw sewage or effluents which is brought about by micro-organisms or other causes is termed "secondary decomposition." The same kind of decomposition takes place in moist or wet sewage mud or sludge, hence the objectionable smell occasionally observed on visiting sewage works. To this paper are appended some results of analyses of sewage muds, giving the principal constituents. The author will consider the sludge question at a later stage; it is the most difficult part of the problem, as most of us know. The author may safely say that both irrigation sewage farming and filtration of raw sewage over or through land is a proved failure, and further that at last the inevitable day of chemical precipitation, supplemented by filtration either through specially constructed filter-beds or over properly prepared filtering land, has arrived and will be the only possible efficient way of purifying sewage in order to fulfil the requirements of these days in regard to it. We cannot any longer allow sham or inefficient processes to be put upon our local rivers for dealing with sewage, because nothing less than absolute efficiency will be allowed if the Manchester Ship Canal is to be a possible waterway to Liverpool and the sea. If some of the present inefficient schemes are not considerably modified, the Irwell water will be too foul for storage in docks, unless the deposit is often cleaned out from the said docks completely. This applies equally to the canal itself. No half measures can be allowed in this case, nothing less than the very best process or processes that science can devise for the treatment of sewage must be adopted for any locality ultimately draining into the river Irwell or any of its tributaries. When sewage in the Irwell and its tributaries or any other river is spoken of, both domestic and manufacturers' sewage are referred to. All of it can be efficiently and easily dealt with now, and there is no reason why the Ship Canal need be troubled with putrescent sewage at all.

Having considered the treatment of sewage by irrigation and also intermittent downward filtration unassisted by chemical precipitation, and also the decomposition phenomena observed when sewage undergoes secondary decomposition, the author will now pass on to the consideration of what are known as precipitation processes. It may be said at once that only those processes which have been for some considerable time in actual practical operation in this country, and further been examined and tested practically by the Corporation of the County Borough of Salford will be considered. In the years 1890 and 1891, the author had the honour of being appointed the referee chemist to the Salford Corporation on the series of important tests of leading sewage processes, which were carried out at the Corporation Sewage Works at Weaste, upon the mixed sewages of the borough. As is well known, the sewage works at Weaste are designed for the treatment of the sewage by what is known as the lime-process. It is unnecessary to describe the works in this paper, as most of you doubtless are well acquainted with it; but for those who have not any knowledge of these works the Salford Corporation have printed a small pamphlet describing it thoroughly, giving at the same time careful drawings of the tanks, &c.

It may be safely asserted that the lime precipitation process is the oldest precipitation process at present in use. For many years it apparently satisfied the requirements of particular localities and no complaints were heard of it, but this "golden age" of the lime process was really fostered by the happy ignorance of the public as to its real character. They thought it produced beautiful, clear effluents, and, best of all, was very cheap. We know to-day that it may be cheap, but it certainly is exceedingly nasty. During the last ten years chemical science has demonstrated beyond any further discussion that an alkaline effluent (where the alkalinity is due to excess of free caustic lime), is one which is more liable to produce secondary decomposition and consequent nuisance, than a neutral or even acid effluent, the reason being the fact that the putrescible insoluble organic matters in suspension are decomposed by the caustic lime and made soluble in water, consequently the effluent water from such a treatment contains in solution a very large amount of partially decomposed organic matter derived principally from fæcal matter in a peculiarly putrescible condition. Further, the albuminoid and other putrescible bodies in solution in the original sewage are converted into unstable compounds which also appear to undergo secondary decomposition with greater facility than they do in the original sewage, after being submitted to the chemical action of caustic lime; consequently in reality the so-called purified sewage is worse than the original raw sewage, so far as secondary decomposition is concerned. Unfortunately this state of affairs is not materially altered by subsequently filtering the lime effluent through any kind of filtering medium, either through land or specially prepared filters of the very best construction. This is accounted for by the fact that the unstable organic compounds referred to are in solution, and also of course partially oxidisable, consequently the land or the filter becomes rapidly choked by the deposition of the slimy, sticky, insoluble, gum-like substance already mentioned above, as being produced by the oxidation of organic matter in sewage. In the author's experience of the lime process, both with and without filtration, he can only confirm the already expressed opinion of other chemists, that the lime process is a delusion and a snare so far as purification of sewage is concerned, and it ought no longer to be allowed to discharge its filthy effluents into streams in a populous district. It is an absolute failure. It is cheap, but if its adoption leads to subsequent costly litigation (as it has been known to do), its cheapness also is part of the delusion connected with it. Another most serious objection to the process is the putrescent character of the sludge and its increased weight. The organic matters mechanically carried down with the lime in suspension, decompose more easily in the presence of free caustic lime than they otherwise would; therefore, before the sludge is removed from the tanks it is already in a state of active decomposition and very foul. When this sludge is pressed in filter-presses, a putrid foul-smelling water runs from the presses, which is very much worse in quality than the original sewage, and must be immediately dealt with, if a nuisance is to be avoided. The author will not consider the question of cost of any of the processes, although of course that is a very important consideration, but only the purely chemical side of the question. The cost must be ascertained by the engineer, and by the alliance of the engineer and the chemist, and in no other way can the great sewage problem be solved.

Many plans have been devised for the so-called disinfection or deodorisation of sewage by various means, some of the mixtures added to the sewage to be deodorised being fearfully and wonderfully concocted, whilst others are simple and scientific in character. The most successful of these, so far, appears to be manganate of sodium, which, as is now well known, has been added to a portion of the Metropolitan sewage. But the success of this process appears to the author to be very doubtful, because unless absolute sterilisation of the treated sewage can be guaranteed throughout its flow and final discharge into the Thames, and still more important after its discharge into the Thames, a serious secondary decomposition will at once arise and produce a great nuisance. Such a very large quantity of manganate of sodium would have to be added to the sewage in order to completely destroy the organic matter in solution and suspension, and thus prevent secondary decomposition, that the process would become too costly. Again, it is more than doubtful whether such an immense volume of sewage as that from the Metropolis could be efficiently intermixed with the manganate of sodium before being discharged from the works. Failing such absolute intermixture, the oxidation of the sewage matters would be imperfect and a nuisance would be the final result.

It is perhaps impossible to-day to say with any certainty who was the first person to suggest the use of iron or its salts in the purification of sewage. For a very great many years, perhaps centuries, it has been often observed that hydrated ferric oxide, or brown hematite, has absolutely replaced the shells and organised structure of mollusca of various kinds, and in some cases fossil fish are occasionally found where the whole structure now consists of iron pyrites (a di-sulphide of iron). Many other similar examples of replacement of organic matter by iron compounds in nature could be cited, but these are sufficient to show that it must have been well known that iron had a very strong affinity for organic matter. One of the first (if not the very first) to apply iron to the purification of water and sewage was the late Mr. Thomas Spencer, analytical chemist, of Euston Road, London, in 1858. In that year he took out a patent for "Improvements in the Treatment of Iron Ores and Ferruginous Sands, and certain Applications arising therefrom," dated June 23rd, 1858, No. 1415.

Solutions of iron, both chlorides and sulphates of the protoxide and peroxide, either singly or mixed, have been used years ago, in conjunction with caustic lime as a precipitant of the iron (either as hydrated protoxide or hydrated peroxide), with, however, only partial success, because the treatment of the sewage by these salts was not succeeded by efficient filtration, and the author has always found that without efficient filtration secondary decomposition takes place. The author has tested various processes in which ferric chloride (perchloride of iron), either free from ferrous chloride (protochloride of iron) or containing varying percentages of that salt, and in all cases has observed one marked and significant phenomenon, viz. the large increase in the amount of free or saline ammonia in the effluent water over that present in the original crude sewage, and an almost corresponding decrease in the amount of ammonia obtained from the nitrogenous or albuminoid matters. This is well shown in Table II., taken from the Report on Sewage Treatment to the Corporation of Salford in 1890.*

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* The other tables, A, B, C, and D, are also taken from the same Report, published by the Salford Corporation, and may be obtained from them on application for the price of one shilling. The Reports are both engineering and chemical, and written by Mr. A. Jacob, C.E., the then Borough engineer, Mr. J. Carter Bell, the Borough analyst, Messrs. John Newton and Son, engineers, and lastly, the author of this paper.

From a chemical point of view it is very difficult to say at present with actual certainty what the action of the iron salt really is upon these nitrogenous bodies. The author is inclined to think, from the results of his investigations on this subject, coupled with the remarkable chemical results obtained by the iron treatment on the large scale at Salford, that the principal function of hydrated oxide of iron is the partial oxidation of the carbon of the albuminoid bodies into carbon dioxide (carbonic acid), with the simultaneous production of free ammonia from the nitrogen of the albuminoid matter, which is in a state of unstable equilibrium in consequence of this partial oxidation, and ready to immediately combine with nascent or atomic hydrogen when brought into contact with it. Now this so-called albuminoid ammonia in the table of analyses is actually free ammonia obtained by the chemical action of a solution of potassium permanganate containing caustic soda in the process of analysis, upon the albuminoid bodies in the sewage or effluent. By this action the carbonaceous matters are oxidised to carbon dioxide and the nitrogen of the thus split-up bodies converted into free ammonia, which is then collected and its amount ascertained. The amount of albuminoid bodies present is thus expressed in terms of free ammonia.

From this it will be seen that the conversion of the nitrogenous matter in the sewage into free ammonia by the action of caustic permanganate of potassium solution is analogous to the reaction produced upon the same albuminoid bodies by the hydrated ferric oxide assisted by the oxygen of the air. The water in the hydrated oxides of iron is basic in this reaction, that is hydroxyl and not true water, therefore the hydrogen and oxygen in it are in an unstable or at all events loosely combined condition, and easily combine with various other elements when in that condition. The reaction which probably occurs when hydrated ferric oxide is brought into intimate contact with carbon and nitrogen in sewage is briefly as follows, viz.—

1st. The hydrated ferric oxide $Fe_2(OH)_6$ is reduced by the carbon (C) into hydrated ferrous oxide $Fe(OH)_2$, and carbon dioxide (CO_2) and hydrogen (H) are produced, the latter however not in the molecular or free state, but only nascent or in the atomic state. The following chemical equation expresses this stage of the reaction, viz.—

$$3Fe_2(OH)_6 + 3C = 6Fe(OH)_2 + 3CO_2 + H_6.$$

In the next stage the ferrous oxide gives up the hydrogen from its hydroxyls to combine with the nitrogen of the albuminoid matter, resulting in the production of free ammonia, whilst it takes up oxygen from the air and reoxidises itself into hydrated ferric oxide, as the following equation shows.

$$6\mathrm{Fe}(\mathrm{OH})_2 + \mathrm{H}_6 + \mathrm{N}_2 + \overset{\text{Water}}{3\mathrm{H}_2\mathrm{O}} + \mathrm{O}_3 = 3\mathrm{Fe}_2(\mathrm{OH})_6 + \overset{\text{Ammonia.}}{2\mathrm{NH}_3}.$$

The two stages of course are continuous in action.

If this accurately represents what takes place when iron as hydrated oxide acts upon sewage, then it is clear that after the precipitant has been added to the iron salt, the settled treated sewage ought to be filtered through land or a properly constructed filter in order to be oxidised, for without this oxidation it is not possible to carry out the whole reaction (as stated above) successfully, and convert the nitrogenous matter into free ammonia.

On looking at the Report on the Sewage Experiments carried out at Weaste in 1890, it will be seen that in three processes iron plays a most important part. In one, the International or "Polarite process," it was added to the raw sewage in the form of ferrous sulphate in the material to which the name "Ferrozone" has been given, and it further was present in the form of a magnetic oxide of iron (to which the trade name of "Polarite" has been given) in the special filter attached to the process. On consulting the report it is evident that the principal part of the purification was brought about by the action of the filter. From experiments made since that report was sent in, it is very probable that the ferrous sulphate undergoes a partial decomposition in the pores of the filter, on the magnetic oxide of iron, or polarite, becoming ferric sulphate. This ferric sulphate is not a stable compound, therefore easily forms basic sulphate of iron with a separation or precipitation out of hydrated ferric oxide, and this substance being retained in the filter, as has been already pointed out, oxidises organic matter and destroys it. There is also no doubt that the peculiar magnetic oxide of iron referred to above also acts powerfully upon organic matters in solution such as those present in sewage effluents. The author has quite satisfied himself on that point, since the above-mentioned report was sent in, by further experiments. The late Mr. Thomas Spencer made a magnetic oxide of iron in 1858 and applied it most successfully to the purification of the water from the river Calder at Wakefield for drinking purposes, and for 25 years the same beds of magnetic oxide were continually working, without the least deterioration in their purifying power. Of course the beds were working alternately, in order to allow of aeration, which re-oxidises the reduced ferric hydrate probably present in the magnetic oxide used. Aeration of the beds was absolutely necessary for a successful result. A better result would be obtained in the Polarite process and less work be thrown upon the filter if a quantity of lime (just sufficient to precipitate out the iron from the ferrozone as ferrous hydrate) were added to the precipitating tanks. Certainly, from the results of the trials, even by simply adding the ferrozone to the sewage, excellent effluents were obtained, leaving really nothing to find fault with. The filter-bed of course is one which plays a most important part in the process, and, the author believes, has now been proved to be very constant in its action. This process ought to have a good future before it.

The next process in which iron plays the part of purifier is the electrical purification process, also described in the above-mentioned report. Briefly, the iron which is the active agent is derived from iron plates placed in cells through which the sewage constantly flows. The iron plates are so arranged that on passing an electric current through the series of cells one set are positive and the other negative. Only the positive plate is acted upon and dissolved upon its surface, the hydrated ferrous oxide mentioned above being produced by the action of the nascent oxygen (liberated by the decomposition of the water at this pole), acting upon the metallic iron. This hydrated ferrous oxide (which is in solution) then acts upon the organic matter in the manner described above, becoming firstly, hydrated ferric oxide by absorption of oxygen from the air, giving up this oxygen again to the organic matter and becoming the lower oxide, and repeating this operation for a considerable time until the carbonaceous matters which are oxidisable have been oxidised, when no further reduction of the ferric hydrate can take place, and it remains insoluble and suspended in the effluent as a yellowish precipitate. In order to cause the plates to wear off or dissolve equally, the poles are reversed on alternate days, a plate being positive one day and negative on another day. Since the issue of the Salford Sewage Treatment Report in 1890, the electrical process has been submitted to a thorough trial, at Weaste, from October 1891 to March 1892, on a specified quantity of 4167 gallons per hour or 100,000 gallons per 24 hours. The current density employed was one ampere for every 7 square feet of electrode surface, or 0·4 ampere-hours per gallon of treated sewage. The electric shoots or channels were constructed in four lengths—the smallest number which would be adopted in practice.

A plan is appended of the electrical treatment tanks, settling tanks, and filter-bed used in this last trial. Each of the four shoots is divided into 34 cells, each cell containing 16 iron plates, each 2 feet by 1 foot 6 inches by ½ inch. The total weight of iron plates employed in this trial was about 55 tons. The plates were connected all parallel in each cell, the cells in each shoot connected in series, and the four shoots parallel. The electrical energy employed was 50 amperes at a pressure of 50 volts, or a little over 4 I.H.P. Each of the shoots was connected by conductors with a distribution board and suitable switches in the engine house, in order to enable the operator to reverse the current of any one shoot when desirable. This reversal of the current was carried out upon one shoot at a time, the other three shoots taking temporarily the whole flow of the sewage. The poles of the shoot in question being reversed, the cells in that shoot were short-circuited, which at once caused a very rapid discharge of the back current. After this had taken place the current was reapplied in the opposite direction through a resistance coil, and the resistance gradually cut out as the normal electrical conditions were established. This is of course an easy matter for any one having the most elementary knowledge of electrical matters, and should present no difficulty in practice. The treated sewage then flows into the 10 settling tanks (2 sets of 5) shown in the plan, each tank being 8 feet wide, 16 feet long, and about 5 feet deep. The sewage flowed continuously through one or other of these sets of five tanks, and over the intermediate walls of each tank, which were provided with double lips in order to assist the oxidation of the effluent. It was found that the production of wet sludge was at the rate of 17·5 tons per million gallons of sewage treated. The suspended matter is principally hydrated ferric oxide, and practically free from organic matter of an objectionable character. The amount of metallic iron used is about 3 grains per gallon of treated sewage, and nearly all this is present in the sludge as hydrated ferric oxide. Experiments were carried out with this sludge, by burning it under proper conditions, when it was found that a red oxide of iron was obtained which could be converted into a pigment. Possibly this pigment may be so produced in a satisfactory condition and disposed of at a price which will cover the cost of production; and thus get rid of the sludge.*

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* For the chemical and engineering results obtained from the working of the electrical process, see Report of 1891.

The suspended matter was removed by passing the settled effluent over the ordinary sand filter beds shown in the plan, and it was found that the filters did not become choked at all, but retained their efficiency from October 1891 to the end of the trial in March 1892. This process has a good future before it, because electrical plant and machinery is being rapidly cheapened and improved every year. From a scientific point of view the process leaves little to be desired.

The last process, tried at Weaste in 1890, in which iron was the principal purifying agent, was the Barry process. This was simply the treatment of sewage by a solution of ferric chloride subsequently treated with enough caustic lime to precipitate out the iron as hydrated ferric oxide. The reactions produced are those expressed by the chemical equations given above, viz. where carbon and nitrogen react upon hydrated ferric oxide. All the other ferric chloride processes more or less produce similar results.

From the second chemical equation it is seen that the presence of oxygen is absolutely necessary in order to reoxidise the ferrous hydrate into ferric hydrate, and further that without this reoxidation the final stage of the purification cannot take place. We see, therefore, that a good filter is absolutely necessary to act as the final oxidiser. The author has found that the magnetic carbide filter produced a very good effluent from an inferior effluent which had been the result of treatment of sewage by ferric chloride and caustic lime. The author has no doubt that iron in the filter itself played a part in the purification, because it was observed that effluents from the lime-process before filtration through the carbide filter did not deposit hydrated ferric oxide on standing; but after filtration through carbide deposited hydrated ferric oxide in considerable amount.

This hydrated ferric oxide was undoubtedly derived from the magnetic carbide in the filter, and was present in the effluent after it had passed the carbide, as ferrous carbonate ($FeCO_3$), and this salt, by absorption of oxygen in the presence of water, became firstly ferrous hydrate, and lastly ferric hydrate. This reaction correctly represents the chemical action of polarite filters and magnetic carbide filters upon carbonaceous organic matter in solution.

Now leaving the treatment of sewage by iron, the author will consider the action of what is called the alumina process. The use of sulphate of aluminium (either alone or with the addition of a quantity of caustic lime sufficient to precipitate out all the alumina), has been well known for many years, and in some places where it has been assisted with efficient filtration good results have been undoubtedly obtained, as at Coventry for example. The process is much too well known to take up time by describing it. The chemical action of alumina appears to be analogous to that of iron in the conversion of the albuminoid bodies into other less stable bodies which furnish afterwards free ammonia, but it does not oxidise the carbonaceous matters because, so far as chemists know, no lower oxide than alumina (Al_2O_3) is known. No oxide corresponding to the ferrous oxide is known, therefore no such reaction occurs as that given above in the reduction of ferric hydrate to ferrous hydrate. If oxidation did occur through the action of alumina hydrate, $Al_2O_3 . 3H_2O$ or $Al_2(OH)_6$, upon the carbonaceous and nitrogenous matter, it could only be brought about by the formation of the hitherto unknown aluminium monoxide, AlO. This substance would of course be in the hydrated state, and have the formula $Al(OH)_2$, and its action would then be analogous to that of the $Fe(OH)_2$ described above. On consulting the Report of the Sewage Trials at Weaste it will be seen that alumina most certainly does not act as an oxidiser ; but it has a peculiar valuable property of its own, the power of combining with nitrogenous and other organic matters and fixing them in itself. It has been known for a very long time that aluminium hydrate, $Al_2(OH)_6$, had the peculiar property of fixing vegetable colours, hence its universal use as a mordant in cotton. In all probability it acts like a mordant upon the organic matters in solution and suspension in sewage, and partially removes them, leaving only that organic matter in solution which requires oxidation. In the Salford Report the author pointed out that in all probability good results would be obtained by this process when assisted by efficient filtration. This is necessary in the alumina process in order to remove by oxidation the soluble putrescible matters still likely to be present in the sewage. The hydrate of alumina, $Al_2(OH)_6$, is a very gelatinous, slimy substance, with a low specific gravity, and one of its most objectionable features is the property it has of closing the pores of the filters most effectually in a very short time. Filters which are used in this process should have constant attention ; the top layer of sand must be removed altogether and well washed. If this is neglected the effluents will in all probability be unsatisfactory.

The author has examined the working of other processes at the

Sewage Works at Weaste since the issue of the report to the public in January 1891, and reported upon what he had seen, but is not at liberty to say anything at present in regard to that portion of the inquiry. Now as to the consideration of the sludge question. Experience has demonstrated in the most absolute manner that all thoughts of ever converting sewage sludge into a valuable manure must be for ever given up. Chemically it has no manurial value at all, because the value of the very small amounts of ammonia and of phosphates in it is far below the cost of carting it upon a field, even a short distance away. Sewage sludge therefore must be considered an unavoidable nuisance to be got rid of in some way or other. In most places the sewage sludge is drained as much as it can be, and then run into some hollow valley, pit, or low-lying ground convenient for its disposal (in short a sludge-tip) and left there. It has been already explained what the micro-organisms do to sewage, and the author repeats now that similar decompositions are brought about by these organisms in the sludge. The nitrogenous matter is converted by two peculiar bacilli into nitrites and nitrates, in the presence of air, one bacillus producing only nitrites and the other nitrates. This discovery was made by Mr. Warington, and published by him some years ago in his work on the nitrification of soils. The author has no doubt at all that the same bacilli produce the decomposition of the nitrogenous matter in sewage sludge, and convert it into nitrites and nitrates.

The author analysed an average sample of fresh sewage sludge from the lime process at the Weaste sewage works, and found it to have the following composition, viz.—

Mineral matter *	6·22	per cent.
Loss on ignition of dry sludge (organic matter) ..	2·50	„
Water	91·28	„
	100·00	

* The mineral matter consists of—		
Silica and insoluble matter	10·418	per cent.
Ferric oxide and alumina	9·511	„
Sulphide of iron	0·115	„
Calcium carbonate	64·526	„
Calcium sulphate	3·621	„
Magnesium carbonate	11·613	„
	99·804	

Analyses of many other samples, from Weaste and elsewhere, prove that the above fairly represents the composition of the mineral portion of the sludge. As we should expect, the predominating constituent of the mineral matter is calcium carbonate, produced by the carbon dioxide dissolved in the sewage reacting upon the free caustic lime in excess in solution, producing of course calcium carbonate. This precipitation of calcium carbonate in the sludge is one of the most serious objections to the use of lime in excess. Messrs. Newton & Son estimated in their report on the engineering portion of the trials at Weaste in 1890, that the amount of sludge produced per annum by the various processes named, calculated upon a daily flow of 10,000,000 gallons, was as follows (expressed in tons), viz.—

	Raw Sewage.	Polarite.	Electrical.	Ferric chloride.	Alumino-ferric.
Dry sludge	5,840	7,500	6,900	12,000	12,000
Pressed cake	11,680	15,000	13,800	24,000	24,000
Wet sludge	58,000	75,000	69,000	120,000	120,000

The amount of sludge obtained on the same quantity of sewage by the lime process is—

Dry sludge	11,420
Pressed cake	22,840
Wet sludge	114,200

The worst feature about sludge is the enormous quantity of water which it contains. It cannot be dealt with at all until nearly half of its original water has been got rid of in some way or other. The only good way is to place it upon a suitable plot of ground, hard underneath, and inclined towards a catch-pit or tank to retain the foul drainings. If placed upon ordinary land, in all probability the same choking-up of the pores will take place as is the case with land used for filtering sewage, and a nuisance must arise. In many cases the underdrainage water from sewage sludge is exceedingly foul and much contaminated with sulphides n solution, which, of course, constitutes it a public danger in sewers or even streams when in quantity.

In a paper like this it would be impossible to lay down any rule for ascertaining whether an accumulation of sludge would be dangerous or not, as this would depend upon very many varying conditions, such as locality, composition of the raw sewage, treatment, mode of working and management, &c. Every effort should be made to diminish the accumulation of sludge. Possibly, by concentrating all the refuse, cinders, and rubbish of a town or district in a sewage works, erecting destructors with the necessary fume-cremators on the spot, to burn this refuse and the pressed sludge-cakes, the nuisance of the accumulation of sewage sludge would be got rid of, and sufficient power obtained to work the pumping engines, &c., when required. The burnt residue at all events would be harmless, and might also be useful. At Ealing a Past President of your Association, Mr. Charles Jones, M.I.C.E., has demonstrated that such a mode of dealing with sewage sludge is practicable and successful.

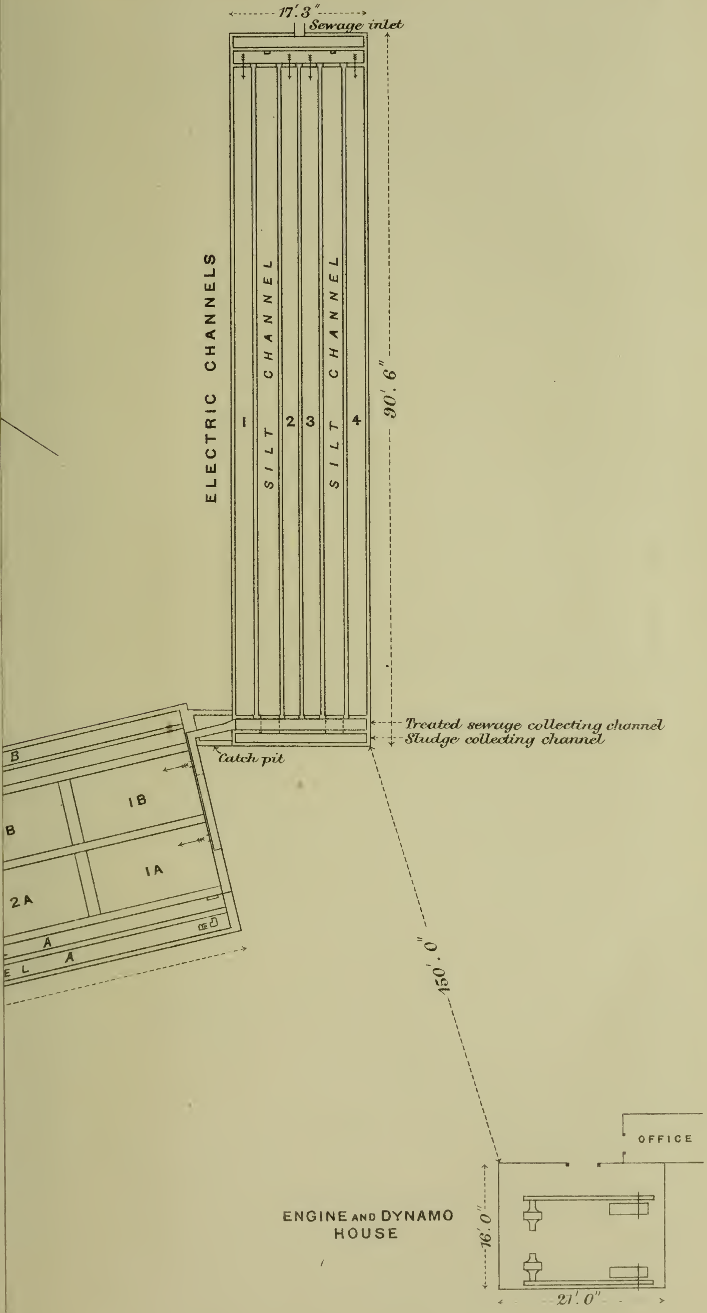
With regard to the pollution of rivers by sewage, the author is of opinion that it is equally incumbent upon Local Authorities to cause the removal of manufacturers' sewage from our rivers in addition to the removal of foul domestic sewage. He pointed out in 1886, and proved most conclusively, that at least one-half of the pollution of the Irwell was due to manufacturers. Appended to this paper are some diagrams which are taken from a paper read by the author "On the Pollution of the River Irwell and its Tributaries," before the Manchester Literary and Philosophical Society, on the 23rd of February, 1886. The analyses from which the curves were plotted are also given. It will be seen that the first sample was taken on January 25th, 1884, and the last on January 16th, 1885, all at the same spot, every Friday morning at 10 A.M. throughout fifty-two weeks. By thus taking numerous samples under similar conditions the author was able to ascertain the condition of the River Irwell in drought, in flood, and during the holiday season, and compare one period with another. On examining the diagram, curve No. 3, it will be seen that the oxygen required to destroy or oxidise the organic matter in 100 parts of the dry solid matter obtained from the river water by evaporation to dryness, rose steadily from March 7th, 1884, to July 4th, 1884. There was a persistent drought throughout that period (this is apparent on examining the diagram of the rainfall at Manchester and Salford for the year 1884), but it will be observed that a most remarkable fall in the amount of oxidisable impurity occurred quite suddenly from May 30th to June 6th, 1884. This week was a universal holiday, Whitweek, and all the works and mills were closed. It will be seen that after Whitweek the oxidisable matter increased in amount until July 4th, when the first rain fell. Only during the high flood of February 1st, 1884 (see rain-curve) was the amount of oxidisable matter as low as in Whitweek. After this it is quite clear that the manufacturers are great pollutors of the Irwell. The author has not depended upon that one year alone for his evidence on this point, but has made similar analyses during other years in the same manner, in order to ascertain whether a similar state of affairs would occur in other Whitweeks and Easters. A most marked and distinct diminution in the pollution during these holidays has always been observed. Much of this pollution by manufacturers is avoidable, and can easily be prevented, without placing any needless hardship upon any industry. Of course we do not wish to place obstacles in the way of trade, but we do expect a reasonable compliance with the requirements of the day in regard to our rivers and must insist upon every reasonable step being taken to reduce the volume of polluting material to a minimum.

If Sanitary Authorities on the one hand, and manufacturers on the other will vie with each other in the removal of polluting matters from our rivers and streams, an impetus will be given to many flagging industries, and the public health will be vastly improved.

In conclusion, the author points out that it is not possible to say dogmatically that this or that process of sewage treatment can be universally adopted. Each district or town has very likely some distinct characteristic, either in the composition of its sewage, in its climate, geographical position, geological conditions, or other cause which must be considered carefully before deciding upon such a very serious and often expensive undertaking as the disposal and treatment of its sewage by any process.

PURIFICATION.

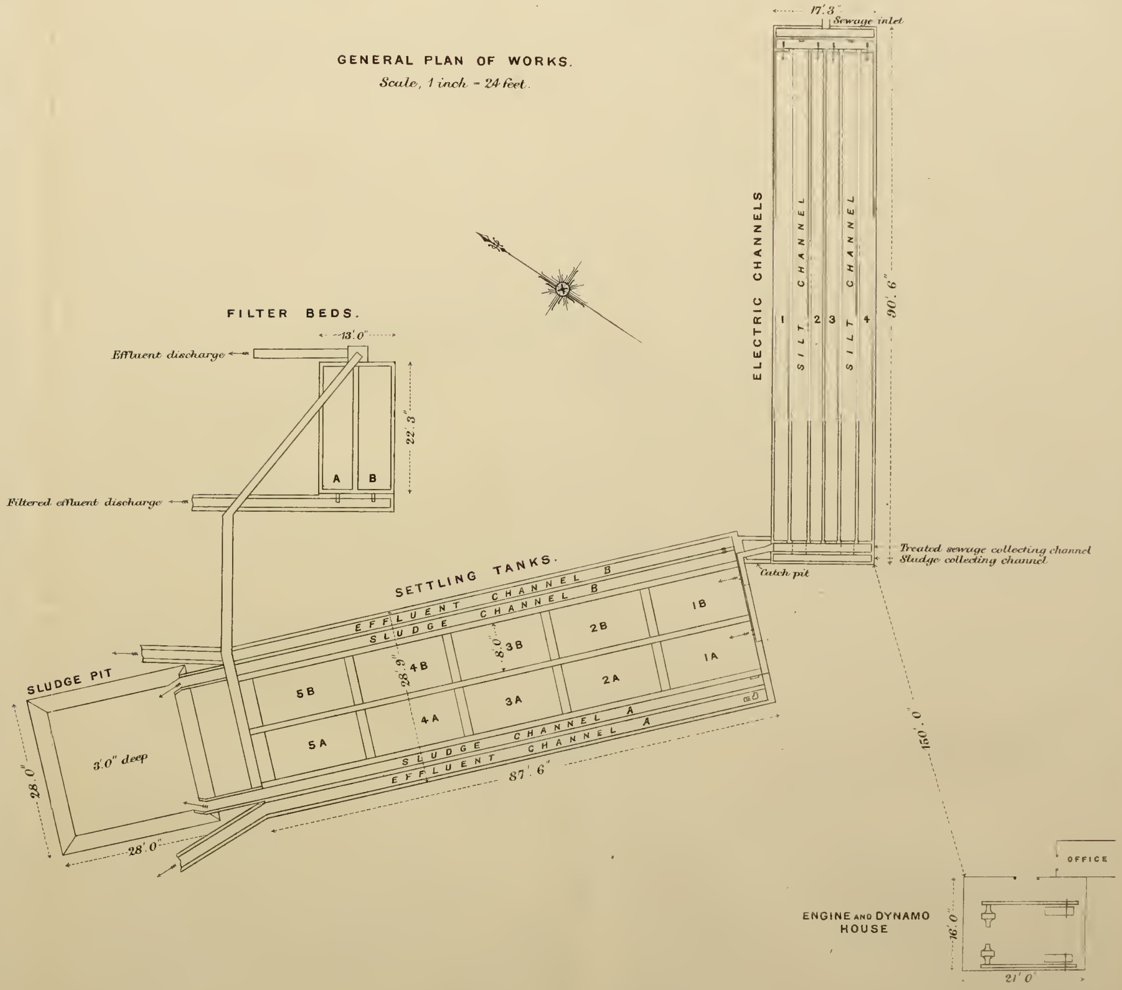
WAGE, SALFORD 1892.



Thos Kell & Son Lith.

SEWAGE AND ITS PURIFICATION.

ELECTRICAL TREATMENT OF SEWAGE, SALFORD 1892.



GENERAL PLAN OF WORKS.

Scale, 1 inch = 24 feet.

C. A. BURGHARDT, Ph. D.

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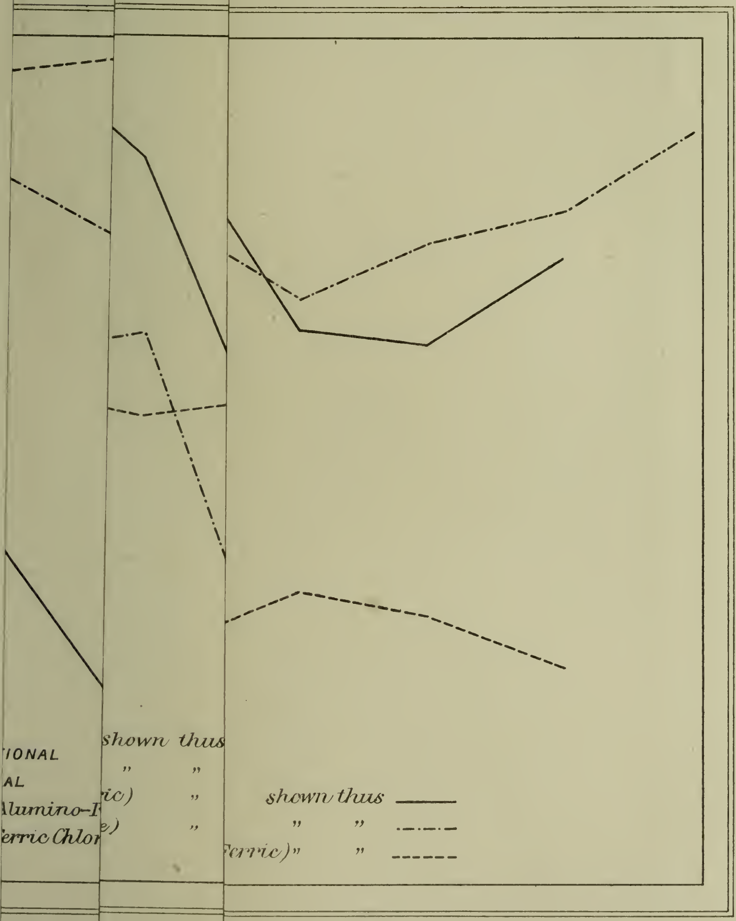

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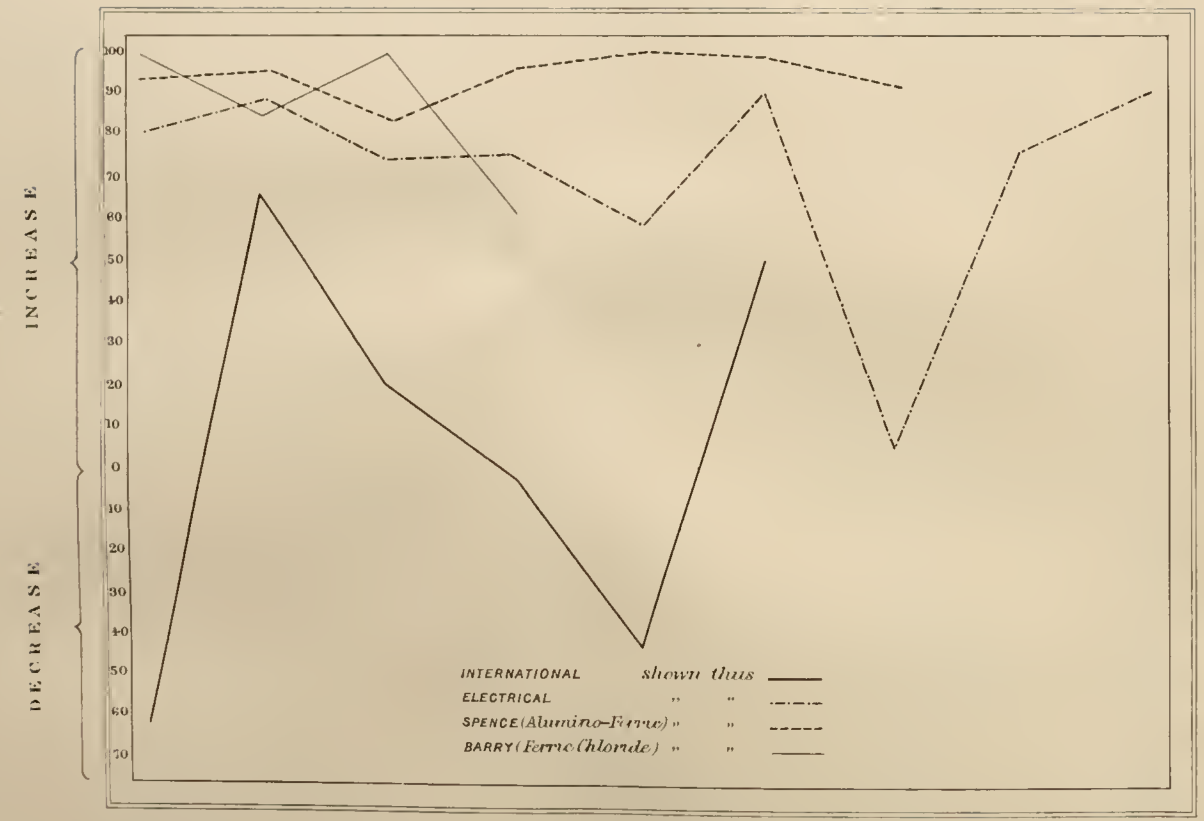
Thos Kell & Son, Lith

SEWAGE AND ITS PURIFICATION.

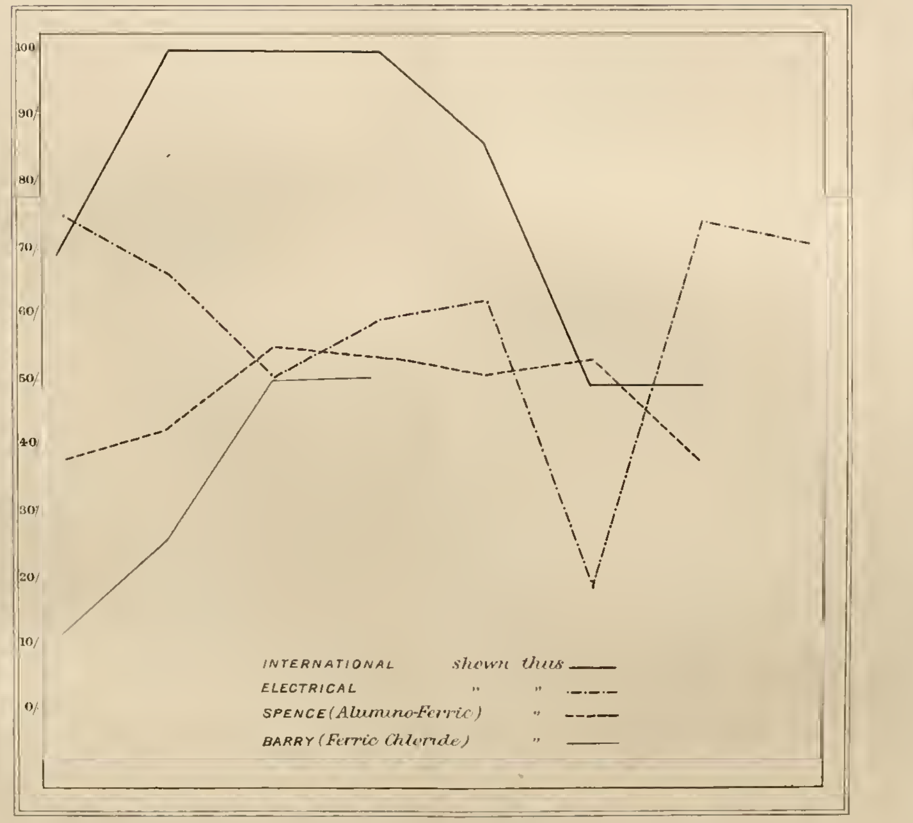
FROM SALFORD SEWAGE TREATMENT REPORT, 1891.

Fig. 3.



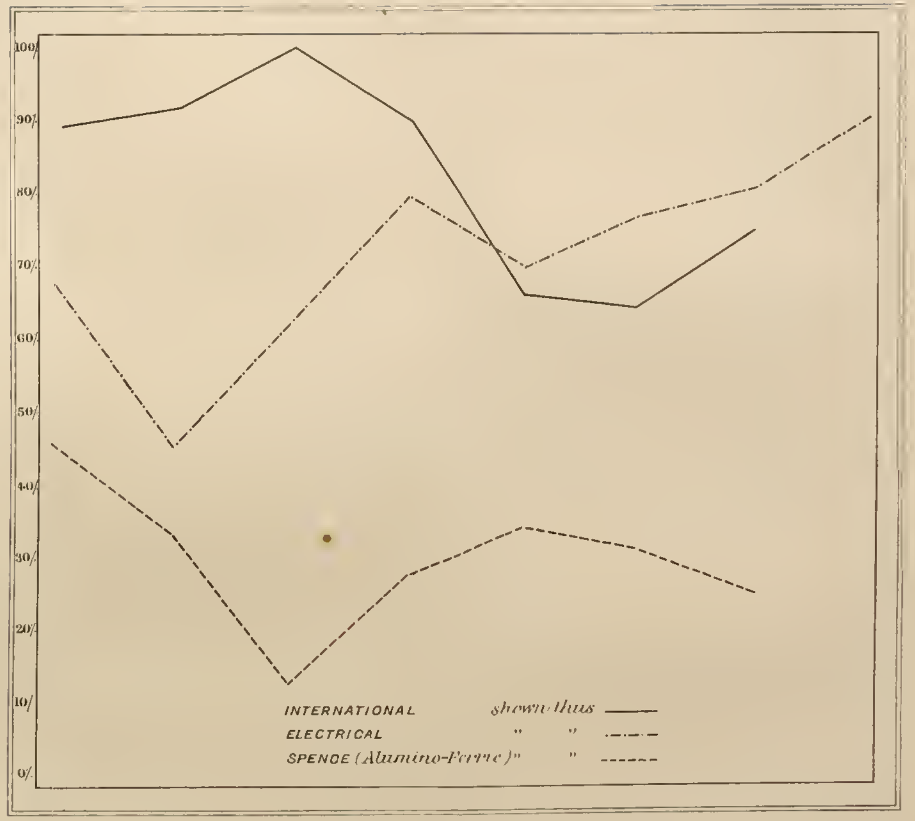
CURVE REPRESENTING THE PERCENTAGES OF INCREASE OR DECREASE OF PURIFICATION IN ORGANIC MATTER IN SUSPENSION (BEFORE FILTERING)

Fig. 4.



CURVE REPRESENTING THE INCREASE IN THE PERCENTAGE OF PURIFICATION IN THE ALBUMINOID AMMONIA (AFTER FILTRATION)

Fig. 5.



CURVE REPRESENTING THE INCREASE IN THE PERCENTAGE OF PURIFICATION IN THE OXIDISABLE ORGANIC MATTER (AFTER FILTRATION)

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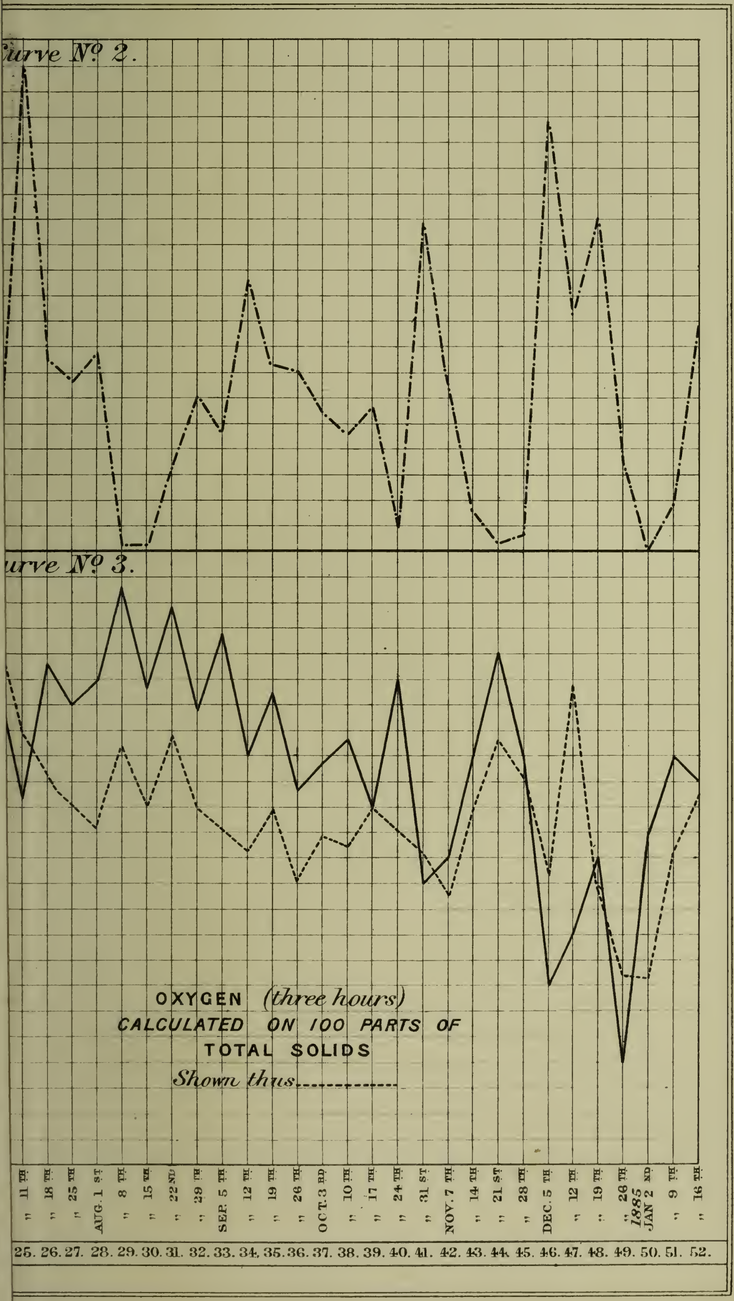
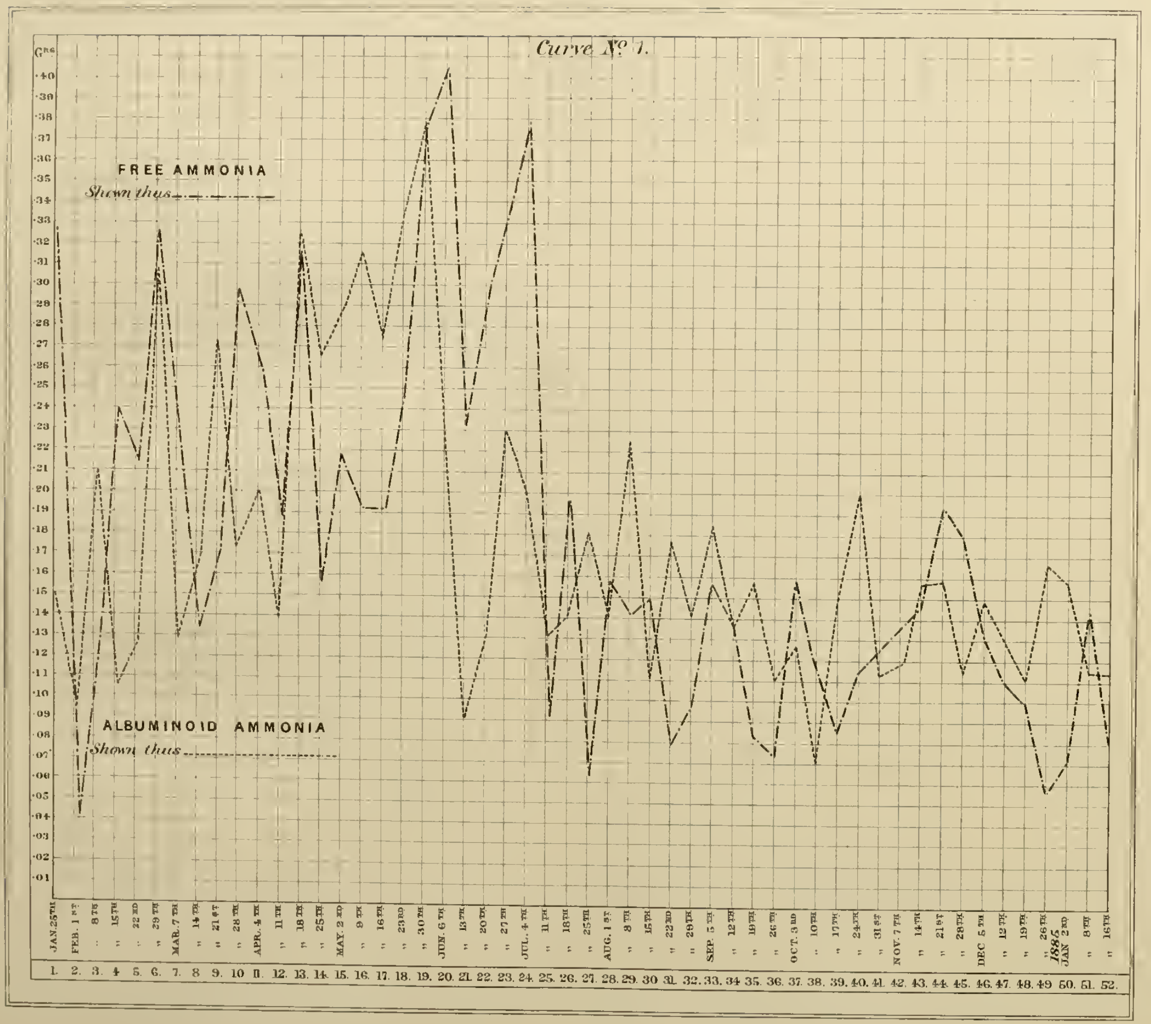
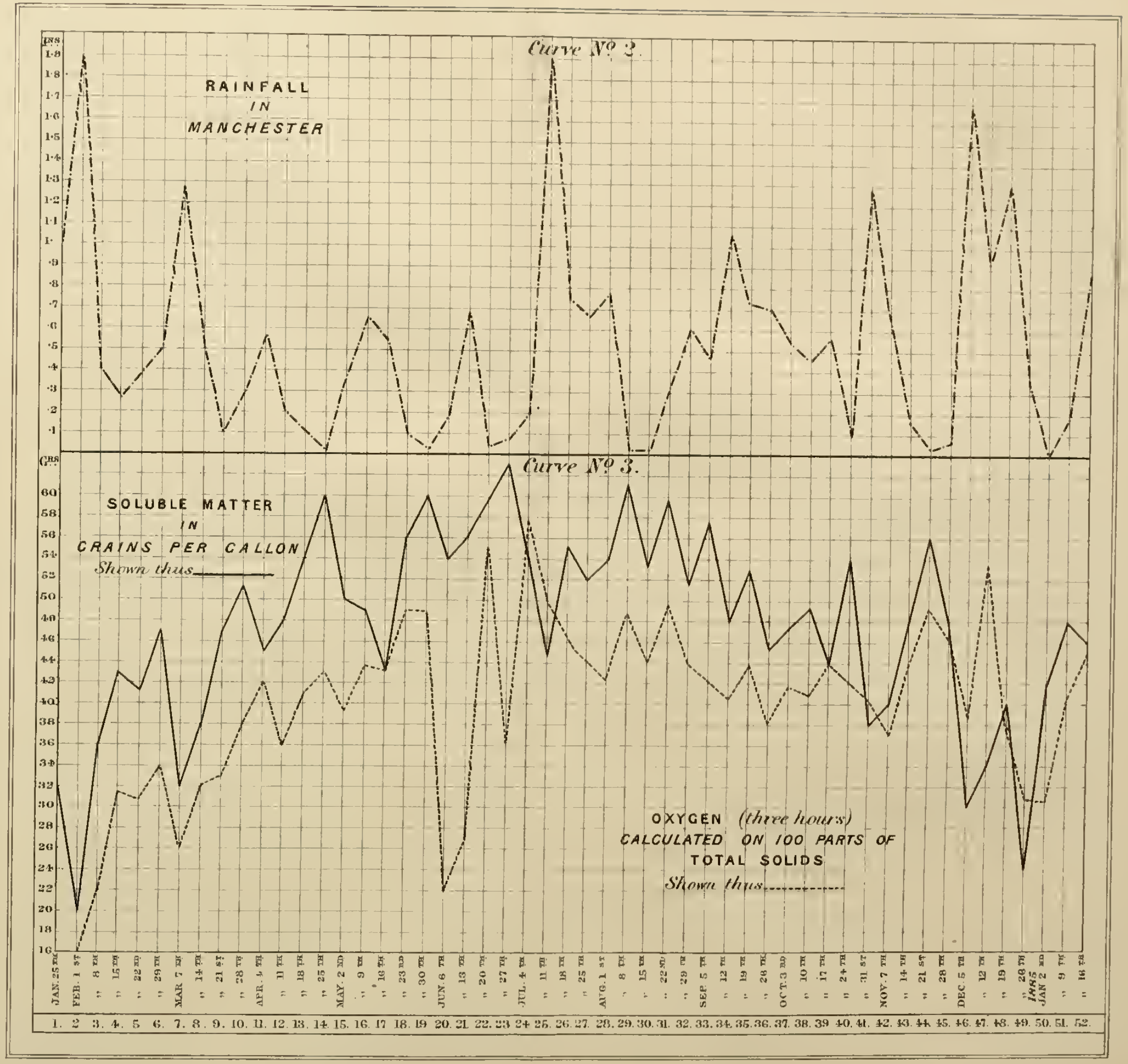


Thos Kell & Son, Lith

SEWAGE AND ITS PURIFICATION.

FROM "THE POLLUTION OF THE IRWELL AND ITS TRIBUTARIES."





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Thos Kell & Son, Lith

From Salford Sewage Treatment Report, 1891.

LIST OF SAMPLES.

INTERNATIONAL.

No. of Sample.	Description.	Date taken.
1	Raw sewage	1890. July 7th
2	Sewage in tank after treatment	"
3	Effluent	"
4	Raw sewage	July 8th
5	Sewage in tank after treatment	"
6	Effluent	"
7	Raw sewage	July 9th
8	Sewage in tank after treatment	"
9	Effluent	"
10	Raw sewage	July 10th
11	Sewage in tank after treatment	"
12	Effluent	"
38	Raw sewage	July 30th
39	Treated sewage in tank after settling four hours	"
40	Effluent	"
41	Average sewage through night	July 30th, 31st
42	Treated sewage in tank No. 1 at 7 a.m.	July 31st
43	Effluent taken at 7 a.m.	"
44	Treated sewage in tank No. 2 at 5.15 p.m.	"
45	Effluent taken at 2.40 a.m.	August 1st

SPENCE PROCESS (ALUMINO-FERRIC).

No of Sample.	Description.	Date taken.
46	Raw sewage	1890. Oct. 14th, 15th
47	Effluent (after standing eleven hours)	Oct. 15th
48	Effluent (one hour after passing out of last tank)	"
49	Effluent	"
50	Average raw sewage	Oct. 15th, 16th
51	Effluent	Oct. 16th
52	Effluent	"
53	Effluent	"
54	Average sample of effluent	Oct. 15th, 16th

ELECTRICAL.

No. of Sample.	Description.	Date taken.
		1890.
13	Raw sewage	July 8th
14	Sewage in tank, after passing conduit (continual flow)	,,
15	Filtered effluent (continual flow)	,,
16	Raw sewage	July 9th
17	Sewage in tank, after passing conduit (continual flow)	,,
18	,, ,, after standing all night and settling	,,
19	Filtered effluent (continual flow)	,,
20	Raw sewage	July 10th
21	After passing conduit and settling three hours in tank	,,
22	Effluent	,,
23	Raw sewage	,,
24	After treatment before filtering (continual flow) ..	,,
25	Effluent (continual flow)	,,
26	Raw sewage	July 11th
27	After treatment before filtering (continual flow) ..	,,
28	Effluent after filtration (continual flow)	,,
29	Raw sewage	,,
30	Treated sewage in tank after settling three hours	,,
31	Effluent	,,
32	Average raw sewage	July 23rd, 24th
33	Treated sewage after fourteen hours running ..	July 24th
34	Treated sewage after settling three hours	,,
35	,, filtered	,,
36	Treated sewage after settling six hours	,,
37	,, filtered	,,

BARRY PROCESS (FERRIC CHLORIDE).

No. of Sample.	Description.	Date taken.
		1890.
55	Average raw sewage	Oct. 16th, 17th
56	Average sample of effluent	Oct. 17th
57	Effluent half an hour after passing out of last tank	,,
58	Effluent at 4.30 p.m.	,,
59	Effluent (after standing eleven hours)	Oct. 18th

From Salford Sewage Treatment Report, 1891.

A.—“ POLARITE ” (INTERNATIONAL PROCESS).

(Figures represent parts per 100,000).

No. of Sample.	Free Ammonia.	Albuminoid Ammonia.	Oxygen taken up in 3 hours.	Mineral Matter in Suspension.	Organic Matter in Suspension.	Mineral Matter in Solution.	Volatile Matter in Solution (Loss on Ignition).
1	1·36	0·50	4·225				8·4
2	2·00	0·80	3·920				14·4
Per cent. of Purification	+ 47%	+ 60%	− 7%				
3	0·15	0·15	0·430				
Per cent. of Purification	− 87·9%	− 70%	− 89%				
4	1·6	0·90	3·271	16·6	11·8	78	16
5	1·6	0·50	1·900	13·4	19·2	85·6	19·2
Per cent. of Purification	Nil.	− 44%	− 42%	19·3%	+ 62·7%	+ 9·8%	+ 16%
6	Nil.	Nil.	0·280	Nil.	Nil.	109·2	36
Per cent. of Purification	− 100%	− 100%	− 91·4%	− 100%	− 100%	+ 40%	+ 126%
7	0·80	1·0	2·20	15·6	29·6	108	30
8	0·76	0·4	2·04	17·2	10·0	104·8	22
Per cent. of Purification	− 5%	− 60%	− 7·2%	+ 10·2%	66·2%	− 2·9%	− 26·6%
9	Nil.	Nil.	Nil.	Nil.	9·2	98	28
Per cent. of Purification	− 100%	− 100%	− 100%	− 100%	− 68·9%	− 9·2%	− 6·6%
10	0·8	0·90	7·900	12·6	37·8	108	40
11	0·8	0·64	6·354	10·4	29·6	88·8	52
Per cent. of Purification	Nil.	− 28·9%	− 19·5%	− 17·4%	− 21·8%	− 17·7%	+ 30%
12	Nil.	Nil.	0·785	Nil.	Nil.	116	26
Per cent. of Purification	− 100%	− 100%	− 90·2%	− 100%	− 100%	+ 74%	− 35%
38	1·44	0·50	2·7	7·28	10·72	101·2	35·6
39	0·6	0·30	2·4	4·20	10·8	104·8	23·2
Per cent. of Purification	− 58·3%	− 40%	11·1%	42 1%	+ 7%	+ 3·4%	− 34%
40	0·19	0·07	0·9	1·00	7·6	112·8	20
Per cent. of Purification	− 85·8%	− 86%	− 66·6%	− 86·2%	− 29·1%	+ 11·4%	− 43·8%
41	1·3	0·30	4·0	6·4	18·6	114·0	42
42	1·5	0·70	5·0	9·0	26·2	110·0	54
Per cent. of Purification	+ 15·4%	+ 134·3%	+ 28·5%	+ 40·6%	+ 40·8%	− 3·5%	+ 28·6%
43	0·5	0·15	1·4	2·0	3·0	128·8	24
Per cent. of Purification	− 61·5%	− 50%	− 65%	− 68·7%	− 83·8%	+ 13%	− 46·3%
44	1·04	0·40	1·8	3·2	9·2	116	46
Per cent. of Purification	− 20%	+ 33·3%	− 55%	− 50%	− 50·5%	+ 1·7%	+ 9·4%
45	0·65	0·15	1·0	1·6	1·0	132·4	20
Per cent. of Purification	− 50%	− 50%	− 75%	− 75%	94·6%	+ 18·6%	− 52·3%

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B.—ELECTRICAL PROCESS. (Figures represent parts per 100,000.)

No. of Sample.	Free Ammonia.	Albuminoid Ammonia.	Oxygen taken up in 3 hours.	Mineral Matter in Suspension.	Organic Matter in Suspension.	Mineral Matter in Solution.	Volatile Matter in Solution (Loss on Ignition).
13	0·8	0·4	3·10	21·2	56·4	97·2	32·4
14	1·0	0·2	0·788	5·74	10·66	83·6	14·0
Per cent of Purification	+ 25·0%	– 50%	– 74·5%	– 72·9%	– 81·1%	– 14%	– 56·8%
15	0·3	0·1	1·00	Nil.	Nil.	85·6	12·0
Per cent. of Purification	– 62·5%	– 75%	– 67·7%	– 100%	– 100%	– 11·9%	– 63%
16	1·20	0·80	2·60	8·8	34·4	117·2	30·0
17	0·94	1·00	Nil.	5·2	4·0	80·8	25·2
Per cent. of Purification	– 21·6%	+ 25%	– 100%	– 40·9%	– 88·3%	– 31%	– 16%
18	1·15	0·26	1·214	2·2	8·6	85·2	12·8
Per cent. of Purification	+ 4·1%	– 67·5%	– 53·3%	– 75%	– 75%	– 27·3%	– 57·3%
19	1·25	0·27	1·408	Nil.	Nil.	86·0	18·0
Per cent. of Purification	+ 4·1%	– 66·[illegible]%	– 63·1%	– 100%	– 100%	– 26·6%	– 40%
20	1·70	0·70	6·278	14·8	31·8	91·6	44
21	1·70	0·40	4·221	2·8	7·8	106·0	16
Per cent. of Purification	Nil.	– 42·7%	– 35·9%	– 81·1%	– 75·4%	+ 15·7%	– 63·6
22	0·90	0·34	2·315	Nil.	Nil.	102·0	18
Per cent. of Purification	– 47%	– 51·5%	– 63·1%	– 100%	– 100%	– 11·3%	– 59%
23	2·00	0·84	6·776	9·0	58·4	107·6	28·0
24	2·10	0·10	3·181	5·2	23·8	90·0	24·8
Per cent. of Purification	+ 5%	– 88·1%	– 53%	– 42·2%	– 59·1%	– 16·3%	– 11·4%
25	1·05	0·34	1·361	Nil.	Nil.	101·2	16·8
Per cent. of Purification	– 47·5%	– 59·5%	– 79·8%	– 100%	– 100%	– 5·9%	– 40%
26	1·30	0·8	8·308	30·4	67·20	133·6	36·6
27	1·90	0·4	4·700	6·44	6·38	98·8	19·0
Per cent. of Purification	+ 46·7%	– 50%	– 43·4%	– 78·8%	– 90·5%	– 26·0%	– 48%
28	1·60	0·3	2·486	Nil.	Nil.	88·4	16·0
Per cent. of Purification	+ 23%	– 62·5%	– 70%	– 100%	– 100%	– 33·8%	– 56·2%
29	1·90	0·50	5·824	8·6	1·2	124·4	25·2
30	2·40	0·34	4·137	6·4	5·6	109·1	18·1
Per cent. of Purification	+ 26·3%	– 32%	– 28·9%	– 25·6%	+ 336·6%	– 12·3%	– 28·1%
31	1·25	0·40	1·381	Nil.	Nil.	125·2	13·4
Per cent. of Purification	– 34·2%	– 20%	– 76·2%	– 100%	– 100%	– 0·6%	– 46%
32	1·3	0·59	4·26	7·8	8·4	100·3	19·8
33	1·3	0·15	1·51	4·2	7·8	67·2	18·0
Per cent. of Purification	Nil.	– 74·6%	– 64·5%	– 46·1%	– 7·1%	– 33%	– 9·9%
34	1·3	0·34	2·13	3·8	2·0	104	24
Per cent. of Purification	Nil.	– 42·3%	– 50%	– 51·3%	– 76·1%	+ 3·69%	+ 21·2%
35	0·95	0·15	0·86	0·8	4·0	112·8	18
Per cent. of Purification	– 26·9%	– 74·6%	– 80%	– 89·5%	– 52·3%	+ 12·4%	– 9·9%
36	1·00	0·4	1·52	2·0	0·8	110·4	27·6
Per cent. of Purification	– 23%	– 32·1%	– 64·3%	– 74·3%	– 90·4%	+ 10%	+ 39·3%
37	1·00	0·17	0·43	1·6	1·6	134	16
Per cent. of Purification	– 23%	– 71·1%	– 90%	– 79·5%	– 80·9%	+ 33·6%	– 19·1%

CHARLES A. BURGHARDT.

C.—Spence Process (Alumino-Ferric).

Figures represent parts per 100,000.

No. of Sample.	Free Ammonia.	Albuminoid Ammonia.	Oxygen taken up in 3 hours.	Mineral Matter in Suspension.	Organic Matter in Suspension.	Mineral Matter in Solution.	Volatile Matter in Solution (Loss on Ignition).
46	0·5	0·8	6·43	5·00	12·40	32·2	63·6
47	0·5	0·5	3·57	1·40	0·80	42·74	79·2
Per cent. of Purification	Nil	− 37·5%	− 44·4%	− 72%	− 93·5%	+ 32·7%	+ 24·5%
48	1·44	0·46	4·30	2·20	0·60	33·01	63·4
Per cent. of Purification	+ 188%	− 42·5%	− 33·1%	− 56%	− 95·1%	+ 0·2%	− 0·3%
49	1·00	0·36	5·70	3·00	2·00	17·00	68·0
Per cent. of Purification	+ 100%	− 55%	− 11·3%	− 40%	− 83·8%	− 47·2%	− 6·9%
50	0·52	0·65	7·50	31·51	25·48	25·26	41·52
51	0·6	0·30	5·44	1·20	1·20	10·90	77·08
Per cent. of Purification	+ 15·3%	− 53·8%	− 27·4%	− 96·2%	− 95·3%	− 56·8%	+ 85·6%
52	0·84	0·32	4·95	1·80	0·20	15·78	37·51
Per cent. of Purification	+ 61·5%	− 50·7%	− 34%	− 94·3%	− 99·2%	− 37·5%	− 9·6%
53	0·6	0·30	5·17	3·00	0·40	..	..
Per cent. of Purification	+ 15·3%	− 53·8%	− 31%	− 90·4%	− 98·4%	..	..
54	1·3	0·40	5·61	1·00	2·00	49·00	38·00
Per cent. of Purification	+ 150%	− 38·4%	− 25·2%	− 96·8%	− 92·1%	+ 93·9%	− 7·8%

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D.—Barry Process (Ferric Chloride).

55	0·56	0·4	..	4·00	2·80	90·00	23·2
56	0·80	0·36	..	Nil	Nil	102·4	28·0
Per cent. of Purification	+ 42·8%	− 10%	..	− 100%	− 100%	+ 13·7%	+ 26·8%
57	0·70	0·30	..	2·00	0·40	98·00	26·3
Per cent. of Purification	+ 25%	− 25%	..	− 50%	− 85·7%	+ 8·8	+ 1·7%
58	0·84	0·20	..	Nil	Nil	100·0	32·0
Per cent. of Purification	+ 50%	+ 50%	..	− 100%	− 100%	+ 11·1%	+ 37·9%
59	0·54	0·20	..	3·00	1·00	91·00	33·0
Per cent. of Purification	− 3·5%	− 50%	..	− 25%	− 64·2%	+ 1·1%	+ 42·2%

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E.—Mean Percentages of Purification.

	Filtered.		Not Filtered.	
	International.	Electrical.	Spence.	Barry.
On free ammonia	− 83·47	− 26·75	+ 56·44	+ 28·37
,, albuminoid ammonia	− 79·51	− 60·00	− 47·38	− 33·75
,, oxygen taken up in three hours	− 82·45	− 73·72	− 29·48	Could not be determined
,, organic matter in suspension	− 79·40	− 91·62	− 93·91	− 87·30

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TABLE P.—VOLATILE ORGANIC MATTER CONTAINED IN 100 PARTS OF THE SOLID MATTERS IN SOLUTION (see Tables X. and 2).

Sample.	Per cent.	Sample.	Per cent.	Sample.	Per cent.	Sample.	Per cent.	Sample.	Per cent.	1885.	
										Sample.	Per cent.
No. 1	25·44	No. 12	26·35	No. 23	30·53	No. 34	29·95	No. 45	22·09		
,, 2	14·72	,, 13	27·74	,, 24	38·25	,, 35	17·84	,, 46	24·24	No. 53	25·54
,, 3	26·64	,, 14	28·47	,, 25	21·58	,, 36	24·29	,, 47	37·50	,, 54	36·79
,, 4	35·57	,, 15	27·70	,, 26	21·46	,, 37	22·76	,, 48	37·93	,, 55	35·87
,, 5	26·65	,, 16	23·07	,, 27	32·17	,, 38	27·27	,, 49	26·66	,, 56	71·02
,, 6	29·72	,, 17	33·11	,, 28	25·26	,, 39	21·22	,, 50	23·38	,, 57	26·55
,, 7	25·25	,, 18	27·06	,, 29	22·66	,, 40	23·43	,, 51	20·34	,, 58	27·33
,, 8	27·24	,, 19	33·29	,, 30	30·65	,, 41	29·10	,, 52	31·33	,, 59	42·68
,, 9	27·64	,, 20	23·31	,, 31	24·01	,, 42	16·55			,, 60	14·51
,, 10	23·46	,, 21	27·08	,, 32	31·59	,, 43	35·60			* ,, 60A	22·87
,, 11	26·94	,, 22	26·06	,, 33	20·27	,, 44	35·75				

* Bury.

TABLE 2.—RESULTS OF ANALYSES OF SAMPLES OF IRWELL WATER TAKEN DURING THE YEAR 1885, ON THE SAME DAY IN THE WEEK AND AT THE SAME SPOT AS IN TABLE A.

No. of Sample.	When taken.	Rainfall during previous week in inches.	Suspended Matter.	Volatile Matter in Suspended Matter.	Total Matter in Solution.	Volatile Matter in Solution.	Chlorine=Sodium Chloride.	Ammonia.		Oxygen absorbed by Organic Matter in		
								Free.	Albuminoid.	3 minutes.	1 hour.	3 hours.
53	Jan. 23rd	0·001	5·040	3·500	51·520	13·160	7·770=12·821	0·1904	0·1792	1·0434	1·3208	2·3954
54	Feb. 27th	0·437	5·768	3·388	35·280	12·880	3·944= 6·508	0·0672	0·1232	0·6860	1·3306	1·6240
55	Mar. 6th	0·837	5·120	3·260	30·440	10·920	4·061= 6·702	0·0672	0·0840	0·4532	0·9304	1·1330
*56	April 3rd	0·875	2·912	1·512	29·969	21·280	3·178= 6·242	0·0672	0·0840	0·4032	0·7097	0·8548
57	May 1st	0·437	4·480	2·770	52·990	14·070	8·123=13·383	0·1624	0·1288	0·1648	1·9782	2·6424
†58	May 22nd	0·737	4·760	1·400	42·000	11·480	4·238= 6·981	0·1792	0·1344	0·5259	1·4112	1·5322
†59	May 29th	0·425	6·300	4·200	51·300	21·900	4·238= 6·981	0·0448	0·0616	0·7560	1·4602	1·8284
60	June 5th	0·025	7·840	5·740	52·080	7·560	9·830=16·198	0·2016	0·2800	1·3181	2·0832	2·4760
‡60A	June 5th	..	2·632	1·232	26·320	6·020	2·472= 3·479	0·0560	0·0070	0·2206	0·5297	0·9944

* Good Friday. † Whitweek. ‡ Bury.

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TABLE R.—Comparative Analysis of the Irwell and its Tributaries during the Year 1885.

Samples.	Suspended Matter.	Volatile Matter in Suspended Matter.	Total Matter in Solution.	Volatile Matter in Solution.	Chlorine = Sodium Chloride.	Ammonia.		Oxygen absorbed by Organic Matter in		
						Free.	Albuminoid.	3 minutes.	1 hour.	3 hours.
Irwell at Bury, before the Roach joins it, Sept. 17th	3·808	1·845	27·440	8·960	2·822 = 4·657	0·0210	0·1750	0·4652	1·0528	1·2032
River Roach, before joining the Irwell, Sept. 17th	3·640	1·400	26·320	8·960	2·822 = 4·657	0·0070	0·1470	0·1351	0·8764	1·0242
Irwell, after the Roach has joined it, Sept. 17th	3·920	1·400	26·880	7·840	2·822 = 4·657	0·0350	0·1750	0·3878	1·0392	1·3413
Irwell, at the Salford boundary, Oct. 30th	1·400	0·700	30·800	12·600	3·551 = 5·852	0·2240	0·0504	0·2772	0·5740	0·6855
River Irk, at the Lancashire and Yorkshire Railway Station, Oct. 30th	8·400	5·600	45·500	15·400	4·939 = 7·894	0·3248	1·9040	0·4133	0·7862	1·1995
River Medlock, just before joining the Irwell	10·300	7·000	63·700	18·200	6·914=11·393	0·4424	0·4704	1·4616	2·3587	2·7821
Irwell, at Throstle Nest, Oct. 30th	4·200	2·100	39·900	14·000	4·939 = 7·894	0·1628	0·2128	0·4636	0·8266	1·0715
Irwell, at Barton, above the locks, Oct. 30th	4·900	2·100	35·700	6·300	4·939 = 7·894	0·2072	0·1064	0·3528	0·7358	0·9778
Bradshaw Brook, at Quarlton Vale, Turton, Jan. 21st, 1885	1·400	1·050	14·700	5·600	1·273 = 2·098	0·0140	0·0224	0·0840	0·2940	0·2940
Tottington Brook, at Bury, before entering the Irwell, June 5th	3·360	2·940	26·600	10·080	3·461 = 5·710	0·0070	0·0560	1·8802	2·7286	3·4122

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TABLE X. (from 'The Pollution of the Irwell and its Tributaries').—RESULTS OF ANALYSIS OF SAMPLES OF IRWELL WATER, taken weekly from 25th January, 1884, to 16th January, 1885. The samples were taken at a spot situated on the right bank of the river, about 200 yards below Trafford Bridge. The results are given in grains per gallon.

No. of Sample.	When taken.		State of River.	Rainfall during previous week in inches.	Suspended Matter.	Volatile Matter in Suspended Matter.	Total Matter in Solution.	Volatile Matter in Solution.	Chlorine = Sodium Chloride.		Ammonia.		Oxygen absorbed by Organic Matter in		
											Free.	Albuminoid.	3 minutes.	1 hour.	3 hours.
1	Jan.	25	High	1·098	4·620	1·246	32·340	8·484	3·725 =	6·146	0·3276	0·1470	0·308	0·616	0·742
2	Feb.	1	Very high	1·924	13·944	2·870	19·964	2·940	4·139 =	6·830	0·0420	0·0980	0·126	0·420	0·518
3	,,	8	Average	0·397	7·140	4·326	36·260	9·660	4·185 =	6·905	0·1470	0·2100	0·294	0·686	0·952
4	,,	15	Very low	0·251	3·584	2·324	43·288	15·400	5·749 =	9·485	0·2380	0·1064	0·504	0·868	1·036
5	,,	22	,,	0·335	4·424	1·862	41·580	11·060	5·795 =	9·561	0·2100	0·1260	0·630	1·204	1·400
6	,,	29	,,	0·512	3·780	2·632	47·852	14·224	5·197 =	8·576	0·3206	0·3178	0·700	1·400	1·708
7	March	7	Rather swollen	1·155	4·340	1·974	33·264	8·400	4·001 =	6·602	0·2324	0·1232	0·308	0·756	0·966
8	,,	14	Lower	0·474	2·660	0·630	39·060	10·640	4·599 =	7·588	0·1218	0·1694	0·539	1·088	1·338
9	,,	21	Low	0·063	7·560	3·850	47·600	13·160	5·316 =	8·771	0·1596	0·2730	0·735	1·582	1·806
10	,,	28	Very low	0·287	3·388	2·268	51·660	12·124	6·734 =	11·110	0·2940	0·1764	0·840	1·635	2·156
11	April	4	Low	0·576	5·278	2·226	44·940	12·110	7·442 =	12 280	0·2506	0·1988	0·854	1·652	2·142
*12	,,	11	,,	0·199	4·340	3·010	47·488	12·516	6·734 =	11·110	0·1820	0·1372	0·714	1·414	1·820
*13	,,	18	Very low	0·074	3·640	2·408	53·900	14·980	7·797 =	12·864	0·3080	0·3276	1·142	1·318	2·473
14	,,	25	,,	0·000	7·196	5·824	60·480	17·220	9·214 =	15·203	0·1568	0·2660	1·238	2·559	2·869
15	May	2	Higher	0·350	5·768	3·472	50·540	14·000	7·088 =	11·695	0·2156	0·2968	0·847	1·692	2·241
16	,,	9	Lower	0·637	6·650	4·830	49·140	11·340	7·797 =	12·865	0·1904	0·3192	1·003	2·013	2·431
17	,,	16	Higher	0·550	5·340	3·332	42·700	14·140	5·670 =	9·356	0·1904	0·2744	0·962	1·183	2·084
18	,,	23	Lower	0·037	6·230	4·508	55·860	15·120	9·569 =	15·789	0·2492	0·3416	1·403	2·538	3·030
†19	,,	30	Low	0·000	4·480	2·912	60·340	20·090	10·132 =	16·719	0·3752	0·3780	1·316	1·650	3·109
†20	June	6	,,	0·125	5·404	3·962	53·410	12·390	4·961 =	8·186	0·4032	0·2408	0·550	1·135	1·329
21	,,	13	,,	0·657	5·712	3·808	55·832	15·120	7·284 =	12·089	0·2304	0·0896	0·745	1·351	1·621
22	,,	20	Very low	0·000	5·726	2·296	60·536	15·778	9·105 =	15·021	0·2968	0·1316	1·029	1·682	3·301
23	,,	27	,,	0·035	5·992	3·780	63·280	19·320	8·802 =	14·523	0·1960	0·2240	1·275	2·146	2·484
24	July	4	,,	0·164	5·548	7·154	53·424	20·440	9·712 =	16·025	0·3696	0·1988	1·771	3·230	3·629
25	,,	11	Low	1·880	5·740	0·140	44·100	9·520	5·158 =	8·511	0·0868	0·1316	0·795	1·676	2·470
26	,,	18	Little higher	0·736	7·000	4·690	55·440	11·900	9·091 =	15·000	0·1960	0·1400	1·313	2·338	2·752

* Good Friday Holidays. † Whitweek Holidays.

TABLE X.—*continued.*

No. of Sample.	When taken.	State of River.	Rainfall during previous week in inches.	Suspended Matter.	Volatile Matter in Suspended Matter.	Total Matter in Solution.	Volatile Matter in Solution.	Chlorine = Sodium Chloride.	Ammonia.		Oxygen absorbed by Organic Matter in		
									Free.	Albuminoid.	3 minutes.	1 hour.	3 hours.
27	July 25	Low	0·650	5·040	2·520	52·220	16·800	6·734 = 11·246	0·0216	0·1848	0·7653	1·8931	2·5200
28	Aug. 1	Very low	0·725	10·080	2·674	53·200	13·440	9·091 = 15·182	0·1596	0·1442	1·2191	2·3256	2·6666
29	„ 8	„	0·000	11·144	0·924	61·040	13·832	10·101 = 16·869	0·1400	0·2296	1·5440	2·9568	3·5070
30	„ 15	„	0·000	6·860	2·492	52·976	16·240	9·428 = 15·745	0·1456	0·1120	1·1728	2·6502	2·6956
31	„ 22	„	0·325	4·900	1·582	58·968	13·160	10·774 = 17·995	0·0728	0·1736	1·3824	2·6246	3·2256
32	„ 29	„	0·575	8·120	5·390	51·464	16·260	8·418 = 15·058	0·0952	0·1400	0·9867	2·3076	2·6330
33	Sept. 5	„	0·487	6·720	4·690	57·316	11·620	9·428 = 15·742	0·1568	0·1840	1·1119	2·2680	2·7784
34	„ 12	„	1·043	5·180	3·066	47·544	12·740	8·418 = 14·058	0·1288	0·1344	1·0906	1·7882	5·1864
35	„ 19	„	0·712	5·880	3·220	52·360	9·520	8·081 = 13·496	0·0784	0·1568	1·1263	2·1312	2·6134
36	„ 26	Higher	0·700	4·088	1·988	44·460	10·800	6·358 = 10·618	0·0728	0·1092	0·7822	1·5725	1·8535
37	Oct. 3	Low	0·537	7·840	3·080	47·432	10·800	7·770 = 12·974	0·1568	0·1288	0·8990	1·7220	2·2960
38	„ 10	„	0·487	3·696	2·548	49·280	13·440	7·417 = 12·387	0·1120	0·0728	0·8873	1·8264	2·1861
39	„ 17	„	0·525	2·380	1·078	43·540	9·240	6·358 = 11·219	0·0840	0·1400	0·8400	1·6786	2·0265
40	„ 24	Very low	0·075	5·180	3·570	53·760	12·600	8·830 = 14·746	0·1120	0·2016	1·2880	2·4556	2·4780
41	„ 31	Low	1·286	2·800	1·300	37·520	10·920	6·711 = 11·247	0·1232	0·1120	0·6216	1·3454	1·6184
42	Nov. 7	Very low	0·687	2·520	0·672	40·180	6·650	4·945 = 8·258	0·1344	0·1176	0·6886	1·4151	1·6170
43	„ 14	Low	0·150	2·800	1·190	47·180	16·800	7·064 = 11·796	0·1456	0·1568	0·8844	1·7038	2·2230
44	„ 21	„	0·025	5·040	3·220	56·000	20·020	8·830 = 14·746	0·1960	0·1568	1·3060	1·9054	3·0730
45	„ 28	„	0·052	8·120	2·660	48·160	10·640	7·417 = 12·386	0·1736	0·1120	1·0822	2·1448	2·5998
46	Dec. 5	Very high	1·687	11·381	2·610	30·187	7·318	2·119 = 3·539	2·1288	0·1512	0·6877	1·4154	1·6170
47	„ 12	Low	0·942	12·501	6·645	33·600	12·600	3·885 = 6·488	0·1087	0·1321	1·2851	2·4164	2·4810
48	„ 19	„	1·299	12·218	7·910	40·600	15·400	4·6269 = 7·682	0·0954	0·1101	0·8400	1·6786	2·0272
‡49	„ 26	„	0·350	9·800	7·700	21·000	5·600	2·119 = 3·539	0·0560	0·1680	0·2180	0·4353	0·9408
	1885.												
‡50	Jan. 2	„	0·000	2·940	1·400	42·392	9·912	4·945 = 8·258	0·0728	0·1568	0·6135	1·2271	1·4014
51	„ 9	„	0·176	5·880	3·670	48·160	9·800	7·064 = 11·796	0·1440	0·1120	0·8651	1·8900	2·2056
52	„ 16	„	0·825	4·370	2·650	42·000	13·160	6·004 = 10·027	0·0840	0·1120	0·8568	1·7406	2·0910

‡ Holidays.

CHARLES A. BURGHARDT.

RIVERS POLLUTION AND RIVERS PURIFICATION.

By H. A. ROECHLING, Assoc. M. Inst. C.E., Leicester.

The subject of the pollution and purification of rivers has been chosen by the author, as he thought this question might prove of interest to a body of gentlemen, who, in the battle of daily life, stand charged with the purification of town sewage without causing the pollution of the streams into which the sewage goes. That such a duty is by no means an easy one cannot be denied, especially in this country, where the rivers are comparatively small, their banks thickly populated, and lined by countless mills and factories. England is rightly looked upon as having taken the lead in the question of practical sanitation, but it is equally true, on the other hand, that it is from England whence the outcry about the pollution of streams and rivers arose. There is no town or village that is not confronted with the solution of this complex problem, which presents a somewhat new aspect in every case, and it was in connection with proceedings against his Town Council for the pollution of the river Soar at Leicester, that the author was for the first time brought face to face with what was in this case an embarrassing problem.

The question of the pollution of our rivers is by no means a modern one, and does not date from the introduction of the system of water carriage of all fæcal matters. It is well known that in all parts of the globe the rivers and streams were looked upon for centuries as the medium for conveying away the filth and refuse of which communities wished to get rid. No doubt as long as the population on the banks of a river remained small, this did not cause a serious pollution, but when the towns increased in size and population, the nuisance such a course entailed became more and more serious, till at last it became an absolute necessity to take all the refuse and filth out of the river and provide other channels for it. This was the commencement of the systematic drainage of towns, which was intended to prevent the pollution of the subsoil of houses and streets, and to keep the rivers and streams within the town free from polluting influences. It cannot be denied that by the introduction of a proper and well-maintained system of sewers and drains for carrying away all refuse water and fæcal matter the first object has been attained, viz. the keeping of the subsoil clean, but as to the second object, the author is afraid that it has not been achieved in all cases. There are towns which purify their sewage, and which cause no pollution in the stream that takes the effluent, and there are others which cause serious pollution. It does not follow, however, that the first set of towns spend more money on sewage purification and purify their sewage to a higher degree than the second set, the sole cause in the difference of results being in some cases the river into which the effluent goes. Some rivers seem to be able to deal successfully with any amount of sewage, others seem to turn sick at the smallest dose. There are, of course, other causes of pollution besides town sewage, such as the waste liquids from mills, factories, mines, &c., but as they are not of so general importance they will not be here considered. It is this different behaviour of the rivers that it is the author's intention to investigate, and to throw, if possible, some light upon what has been called the self-purifying power of a stream. For this purpose the author does not intend to confine himself to English rivers only, but purposes to review American, French, and German rivers as well, so as to give a complete survey of the present state of our knowledge of this question.

It will, of course, be admitted that no town has a right to keep its subsoil clean by a system of drainage, and to dispose of its filth to the disadvantage of perhaps smaller communities lower down the stream by polluting it; but, on the other hand, it will equally be admitted that a town has a right, after effective treatment, to turn the effluent from its sewage works or sewage farm into the river on the bank of which it is situated: the degree of effectiveness of such treatment must be the state of the river after it has received the effluent. If the river is turned into a black boiling mass of putrefaction by the effluent the purification of the sewage is said to be a failure, but if it is left sweet and pure after proper admixture we look upon the treatment of the sewage as successful.

It is the river that decides the degree of purification which must be attained by the sewage treatment, and in this respect any well-considered scheme of sewage disposal or sewage utilisation must start from the purifying powers of the river into which the sewage effluent is to go. The author is afraid this point has been overlooked in a good many cases, and rivers have been called upon to do work for which they were utterly unfit, hence their pollution. It may not be possible in all cases to preserve the river water below large towns in that state of purity which it possesses near its source, but it is absolutely necessary to prevent its systematic pollution, be it by the effluent from sewage works or the waste liquids from mills, factories, &c. In this respect the author cannot but think that it is a wise course to tap rivers near their source for the supply of large towns, and not to rely on river water as is the case in London, that has swallowed the sewage of a population of something like a million residing in two hundred and two towns and villages.

Previous to 1866 this question had not received official attention, and it was left to chemists such as the late Dr. Letheby to study this question in connection with sewage disposal works. In that year, however, owing to the complaints about the bad condition of some rivers becoming louder and louder, a Royal Commission was appointed to investigate the cause of river pollution, and to suggest remedies. It issued two valuable reports, and was succeeded in 1868 by a second Rivers Pollution Commission, which sat until 1874, and issued six lengthy reports. Since then this question has been repeatedly studied both at home and abroad. Notable amongst these investigations are those made by the Massachusetts State Board of Health on the rivers within its territory, by the French Commission of 1874 on the Seine at Paris, by Brunner and Emmerich, 1874–75, and also by Prausnitz, 1887–88 and 89, on the Isar at Munich; by Hulwa, 1877–81, on the Oder at Breslau; by Frank on the Spree at Berlin, 1886–87; by Celli and Scala on the Tiber at Rome, 1890. The late Dr. Tidy has also gone very fully into this question, and read two elaborate papers in 1880 and 81 on this subject before the Chemical Society.

In order to give some idea as to the composition of town sewage, the author has prepared Table I. in which he has compared the sewage of several European towns. It will be noticed that they do not vary very much from the average composition. In Table II. the sewage of water-closet towns and midden towns is compared, and it will be seen that there is not much difference between them. This has been done to disprove what is sometimes asserted, viz. that the whole difficulty of sewage purification would be practically non-existent were the fæcal matters kept out of the sewers, and only the waste water from houses and the rain water carried away in them. Table III. gives some analyses of waste liquids from mills and factories, from which it can be seen at a glance that these wastes are far more powerful sources of pollution than ordinary town sewage. The influence towns exert upon a river that flows through them can be learnt from Table V. In the case of Bradford, for instance, the Beck below the town contained in 1869 over ten times as much ammonia and organic carbon as it did above the town, and nearly five times as much organic nitrogen. In Leicester too, the Soar below the town was in August 1884 seriously polluted, though not to the same extent as the Bradford Beck. A great number of similar cases might be quoted, but the three stated will suffice to give some idea of the deterioration of river water in its passage through populous towns.

Tables V. to XXI. contain analyses of the following rivers :—

Table.	River.	Country.	Name of Analyst.
A.—V.	Thames	England	Rivers Pollution Commission.
VI.	Do.	,,	Dr. P. F. Frankland.
VII.	Mersey	,,	Rivers Pollution Commission.
VII.	Irwell	,,	Ditto.
VIII.	Soar	,,	Dr. Tidy.
IX.	Severn	,,	Ditto.
X.	Shannon	,,	Ditto.
XI.	Ure	,,	Dr. P. F. Frankland.
XI.	Ouse	,,	Ditto.
B.—XII.	Blackstone River	North America	Massachusetts State Board of Health.
XIII.	Charles River	,,	Ditto.
XIV.	Merrimack River	,,	Ditto.
XV.	Beaver Dam Brook	,,	Ditto.
C.—XVI.	Seine	France	Commission of 1874.
D.—XVII.	Spree	Germany	Frank.
XVIII.	Isar	,,	Prausnitz, &c.
XIX.	Elbe	,,	Board of Health.
XX.	Oder	,,	Hulwa.
XXI.	Nebel	,,	Heyroth.

It will be noticed that some of the rivers of which analyses are given in the Appendix have tidal portions, and it is necessary to state here that in the investigations for this paper these portions are not included. The reason of this is not far to seek, the conditions in the non-tidal portions being so different from those in the tidal portions, that it is impossible to combine them in one set of investigations and to arrive at combined conclusions; and as the consideration of a non-tidal river is of far more general importance than that of a tidal one, the author only deals with the former class of rivers in this paper, leaving the examination of rivers that are tidal for a future occasion. It was not possible in all cases to give particulars concerning the velocity and discharge of the river under review, and the author regrets that sometimes elaborate analyses of a river at various points of its course are given without any attempt to convey some idea as to its discharge at these places, and as to the quantity of sewage that is poured into it. No definite conclusions can be arrived at without a full knowledge of these factors.

To judge of the state of any river it is usual to note its state as it appears to the naked eye, and to take samples of the water for chemical, microscopical, and lately also for biological examination. In the incipient stages of pollution it is difficult sometimes to detect it with the naked eye, but when the pollution has advanced further, the turbidity of the water, its colour and smell, are sure indications of it. The chemical examination should be carried out as soon as possible after the samples have been collected, otherwise further changes in the water will take place, and it cannot be said to express the various degrees of pollution so clearly as the biological one, which gives the germs per cubic centimetre. This can be seen very clearly from the analyses of the water of the Spree at Berlin, and of the Nebel near Guestrow. In the case of the Spree, for instance, the amount of oxygen consumed lies between 1·69 and 2·30 parts per 100,000, whereas the number of germs discovered ranges between 6141 and 329,905 per cubic centimetre. In this country it has not been customary up to the present time to examine water biologically, but on the Continent and in America the biological analysis now generally accompanies the chemical one.

The late Dr. Letheby stated before the Royal Commission on Water Supply in 1869 that he had made a very great number of chemical experiments to determine the self-purifying powers of our rivers and streams. He had also examined most of the rivers in England, and the conclusion he had come to was this, that if ordinary sewage, containing, say, nearly 100 grains of solid matter per gallon, such as the London sewage, out of which probably something like 14 or 15 grains were organic, be mixed with twenty times its bulk of the ordinary river water, after a flow of a dozen miles, not a particle of that sewage would be discovered by any chemical process. The late Dr. Tidy, who at one time was assistant to Dr. Letheby, held very similar opinions, and in a paper read some years ago at the Chemical Society he stated, that if sewage be discharged into running water the organic impurities would after a flow of a few miles be entirely destroyed or got rid of, the water once again assuming its normal condition of purity. He was of opinion that this power of self-purification depended on the subsidence of the suspended matters, on the presence of animal life in the river, and on the oxidation of the organic matter. The second Rivers Pollution Commission, after having investigated the case of the Irwell, Mersey, and Darwen, which were at the time the examination was made highly polluted streams, and the case of the Thames, and after having made some laboratory experiments, came to conclusions somewhat opposed to those held by the late Drs. Letheby and Tidy. For whereas these two gentlemen were of opinion, that both the suspended impurities as well as the dissolved organic matter, the former by subsidence, the latter by oxidation, were completely removed after a certain length of flow, the Commission held, that though the flow of a river had a most material influence in the removal by subsidence of a large proportion of the suspended impurities, both organic and mineral, especially if the flow was sluggish in places, yet the oxidation of the organic matter proceeded with extreme slowness even when the sewage was mixed with a large volume of unpolluted water, and that it was impossible to say how far such water must flow before the sewage matter became thoroughly oxidised—in fact, it would be safe to say, that there was no river in the United Kingdom long enough to effect the destruction of sewage by oxidation. On the Continent of Europe the opinions on this question are very similarly divided. It was the author's privilege to take part last year in the deliberations of the German Association for the Promotion of Public Health, and he had the pleasure to listen to a long argument by the veteran German sanitarian, Prof. Dr. Pettenkofer, in favour of the total annihilation of sewage in river water when the amount of water in the river was never less than fifteen times that of the sewage and the velocity of the former at least equal to that of the latter. The Prussian Government and that of several of the minor states appears to have been guided at first by considerations proceeding from views similar to those expressed by the Rivers Pollution Commission, but latterly a change of opinion in this respect is noticeable and more weight is attached to the opinion of Prof. Pettenkofer.

It cannot, of course, be denied, that almost any river some miles below the point where it has received polluting liquids, looks fairly clarified again, the distance in each case depending mainly on the degree of dilution; but it does not follow by any means that the river has purified itself during this length of run. All those who are endeavouring to purify sewage either by artificial or natural means will know that there is practically not much difficulty in getting rid of the suspended matters and that the main difficulty lies in the removal of the dissolved organic pollution. Of course there can be no such thing as self-purification if the organic pollution remains in the river, and it is with reference to this point that opinions differ so materially.

The author will not attempt here to give in full his examination into the rivers in various countries of which analyses are given in the Appendix, as with the aid of the tables any Member wishing to do so can follow this course. Suffice it to say that the whole of the rivers were examined and due consideration given to each case, and that the following conclusions were arrived at:—

1. That rivers possess self-purifying powers.
2. That these powers are in the main limited to the sedimentation of the suspended matters and germs.
3. That though rivers do possess the power to oxidise the organic matter in them, yet, owing to this power being small, the process is a slow one; and
4. That the distance, over which the process of self-purification goes on depends chiefly on the velocity of the river and the quantity of water flowing in it (degree of dilution).

These conclusions should not, however, be taken as final, as there is undoubtedly a great deal of further information required before this subject can be considered to have been exhausted. It is necessary that all the public bodies charged with the care of our rivers and streams should make complete examinations of the rivers, &c., within their district, somewhat after the manner the Massachusetts State Board of Health has done. Such examination should extend over the period of twelve months at least, and should comprise, besides careful chemical and biological examinations of both the water in the river at different points of its course, and the sewage and waste liquids which it receives, exhaustive inquiry into the drainage area of the river, its geological formation, its rainfall, its population, the velocity and the discharge of the river at the points selected throughout the year, and the amount of polluting liquids poured into it. Such investigations will at the same time afford valuable information concerning the question of the water supply to towns. In this respect the present Royal Commission on the Water Supply to the Metropolis is collecting valuable information concerning the Thames.

From the conclusions at which the author has arrived it will be seen that they lie somewhat midway between those expressed by the Rivers Pollution Commission and by the late Dr. Letheby.

There are undoubtedly rivers which purify the sewage within a very short distance, and there are others where the river cannot right itself for miles. The former is the case where the degree of dilution is a very high one, i. e. where the quantity of sewage is only a very small fraction of the flow in the river; the latter is the case where the sewage does not get much diluted by the river water. But wherever a river receives more sewage than it can deal with, it almost loses its power of self-purification.

Prof. Pettenkofer proposes that the city of Munich should use the river Isar experimentally as a sewage farm. The drainage scheme for Munich was designed by the late Mr. Joseph Gordon in such a manner that the sewage, if required, can be applied on land without the aid of pumping. It is now proposed to establish a few roughing filters near the river to take out all floating matter, and then to let the raw sewage go into the Isar. If it can be proved at any time that such a course is fraught with danger to the river and the communities lower down its course, then the present outfall can be used as a storm overflow and the sewage treated on land. The population of Munich now amounts to 285,000, and when completely sewered the maximum flow of sewage will amount to about 35 cubic feet per second. The discharge of the Isar at low water is about 1400 cubic feet per second, and its velocity at this time 4 feet per second. In this instance the sewage amounts to $\frac{1}{40}$ or 2·5 per cent. of the flow in the river at low water, and Prof. Pettenkofer, after having investigated the case thoroughly, is sanguine that no pollution will ensue in this particular case. It is quite impossible in the present state of our knowledge to lay down a general rule as to the degree of dilution which marks the boundary between the permissible and the not permissible quantity of sewage, as this will have to be ascertained for each river in particular, the conditions varying in each case. It has already been stated that Prof. Pettenkofer is of opinion, that if the sewage does never amount to more than one-fifteenth or 6·7 per cent. of the river water, and the velocity of the latter is at least equal to that of the former, then raw sewage may be poured into such river without causing pollution.

In America, J. P. Stearns, the Engineer to the Massachusetts State Board of Health, who has written a very able report on this subject, came to conclusions from which the author has deducted the following. If the sewage amounts to more than $\frac{1}{40}$ or 2·5 per cent. of the quantity of river water it cannot be discharged into the river in its raw state; if it amounts to less than $\frac{1}{40}$ or 2·5 per cent. and more than $\frac{1}{130}$ or 0·008 per cent. it is doubtful whether it may be admitted; but when the sewage amounts to less than $\frac{1}{130}$ or 0·008 per cent. of the river water, then it may be admitted without any doubt in its raw state into the river. Stearns adds that these considerations are made from the "standpoint of the offensiveness of the water." From other standpoints, however, such as the use of water for certain manufacturing purposes, the amount of dilution should be greater, and in a stream used for domestic water supply it cannot be said, with our present knowledge, that any degree of dilution will make the water entirely safe for use.

In this country the results obtained from the discharge of raw sewage into the rivers have been very disastrous, the population of our towns being large, and the flow in the rivers small compared with the Continent and North America. After much careful consideration the late Commission on the Metropolitan Sewage Discharge came to the conclusion that in England it was not safe to turn even the effluent from chemical works into a running stream which did not carry twenty times more water than sewage.

The question of keeping our rivers pure and sweet is one fraught with many difficulties, which ever increase from year to year, and those who are responsible for their state have by no means an easy task both in this country and abroad; and as this is in the author's opinion an international question, he has thought it might be of some interest to this Association to have besides information from home, some from other parts of the globe bearing upon it.

TABLE I.—ANALYSES OF RAW SEWAGE IN VARIOUS COUNTRIES. Parts per 100,000.

Raw Sewage.	Dissolved Matters.							Suspended Matters.			Germs per cubic centimetre.
	Total Solids.	Mineral.	Organic.	Ammonia.		Oxygen required for oxidation of organic matters.	Chlorine.	Total.	Mineral.	Organic.	
				Free.	Organic.						
1. London sewage (181 analyses) ..	84·7	57·1	27·6	4·51	0·55	..	15·0	39·1	17·9	21·2	..
2. Average sewage of fifteen English towns (236 analyses)	74·81	55·94	18·87	3·763	0·819	2·77	9·93	35·13	16·24	18·89	..
3. Lawrence sewage, Massachusetts, U.S.A. (15 analyses)	42·0	25·7	16·3	1·79	0·38	..	5·14	12·4	3·8	8·6	609,186
4. Paris	98·0	25·0	73·0	..	2·1	..	..	181·9	132·1	49·8	20,000
5. Berlin sewage (30 analyses)	104·51	73·18	31·33	10·69	2·11	8·75	21·85	113·85	38·36	75·49	38,000,000
6. Breslau sewage (12 analyses)	69·96	49·36	20·60	10·38	..	5·36	14·54	42·95	11·83	31·12	..
7. Danzig	68·3	52·2	16·1	6·46	1·16	..	..	58·2	22·6	35·6	..
8. Frankfort-on-the-Main (8 analyses)	89·8	38·1	51·7	6·3	1·1	1·8	..	116·4	35·8	80·6	..
Averages	79·01	47·07	31·94	6·270	1·174	4·67	13·29	74·99	34·83	40·16	..

TABLE II.—ANALYSES OF SEWAGE FROM WATER-CLOSET AND MIDDEN TOWNS. Parts per 100,000.

Raw Sewage.	Number of Analyses.	Dissolved Matters.							Suspended Matters.		
		Total Solids.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Chlorine.	Total.	Mineral.	Organic.
Raw sewage from 16 water-closet towns, England, average.. ..	50	72·2	4·696	2·205	6·703	0·003	7·728	10·66	44·69	24·18	20·51
Raw sewage from 15 midden towns, England, average.. ..	37	82·4	4·181	1·975	5·435	0·0	6·451	11·54	39·11	17·81	21·30

NOTE.—For agricultural purposes 10 tons of average water-closet sewage may in round numbers be taken to be equal to 12 tons of average privy sewage.

TABLE III.—ANALYSES OF WASTE LIQUIDS FROM MILLS, FACTORIES, &c. Parts per 100,000.

Description of Waste Liquids.	Dissolved Matters.							Suspended Matters.		
	Total.	Mineral.	Organic.	Ammonia.		Oxygen required.	Chlorine.	Total.	Mineral.	Organic.
				Free.	Organic.					
1. Waste liquid from flannel washing, England	1248·00	..	..	80·012	..	..	160·00	2079·4	346·0	1733·4
2. „ „ woollen dye-vats „	107·60	..	..	0·492	..	..	..	102·0	24·08	77·92
3. „ „ a blanket mill „	678·00	..	..	0·94	..	..	35·60	374·60	60·40	314·20
4. „ „ galvanising works „	1986·0	..	..	..	..	..	..	34·04	17·76	16·28
5. „ „ German silver manufacturers, England	1613·0	..	..	..	..	..	..	40·40	32·12	8·28
6. Waste liquid from manufacturing chemists, England	1249·0	..	..	..	..	..	..	68·6	21·6	47·0
7. Waste liquid from wire manufacturers, England	1009·4	..	..	..	..	..	..	168·08	132·52	35·56
8. Waste liquid from brassfounders, England ..	55·70	..	..	..	..	..	..	15·20	11·28	3·92
9. Dye and bleach refuse „ ..	144·8	..	..	..	..	..	..	47·2	..	..
10. Waste liquid from bleach works „ ..	147·2	..	..	..	..	..	..	51·6	..	..
11. „ „ a brewery, Germany ..	47·12	23·08	24·04	Trace.	1·49	8·64	..	19·64	2·32	17·32
12. „ „ a cotton mill and dye works, Germany	73·88	39·96	33·92	Trace.	0·83	19·68	..	217·36	108·12	109·24
13. Waste liquid from a sugar mill, Germany	79·25	40·25	39·00	..	..	30·16	..	475·75	417·75	58·00
14. „ „ a straw paper mill „	..	..	..	0·35	7·93	113·36	..	146·44	..	..

TABLE IV.—INFLUENCE OF TOWNS UPON STREAMS. Parts per 100,000.

Place where Sample was taken.	Dissolved Matters.														Suspended Matters.		
												Hardness.					
	Total Solids.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Metallic Arsenic.	Chlorine.	Common Salt.	Nitrogen = Nitric Acid.	Oxygen required to oxidise organic matter.	Temporary.	Permanent.	Total.	Total.	Mineral.	Organic.
Bradford Beck, above Bradford, 5th October, 1869	44·0	0·349	0·081	0·105	0·268	0·435	0·	1·87	..	..	..	1·34	10·46	11·80	trace	trace	trace
Bradford Beck, below Bradford, 5th October, 1869	75·5	4·024	0·392	1·220	0·	1·397	0·002	5·45	..	..	..	10·76	13·75	24·51	52·00	15·95	36·05
Irwell, near its source, 12th June, 1869	7·80	0·187	0·025	0·004	0·021	0·049	..	1·15	..	..	..	..	..	..	0·	0·	0·
Irwell, below Manchester, 17th June, 1869	50·75	1·892	0·264	0·371	0·177	0·746	0·022	8·73	..	..	..	..	..	..	4·16	2·10	2·06
River Soar, above Leicester, 15th August, 1884	59·14	0·33	0·06	0·01	..	..	..	2·366	3·877	0·	0·10	..	..	38·71	..	..	..
River Soar, below Leicester, 15th August, 1884	83·77	0·74	0·08	0·40	..	..	..	4·626	7·586	..	0·45	..	..	34·9	..	..	..

TABLE V.—RIVER THAMES. Parts per 100,000.

Place where Sample was taken.	Approximate Distance, Miles.	Dissolved Matters.											Suspended Matters.		
										Hardness.					
		Total Solid Impurity.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Previous Sewage or Animal Contamination.	Chlorine.	Temporary.	Permanent.	Total.	Mineral.	Organic.	Total.
Thames, ¼ mile below junction with Kennet, 2 p.m., 31st May, 1873	0	28·86	0·261	0·071	0·007	0·167	0·244	1,410	1·70	15·8	6·9	22·7	0·42	0·06	0·48
Thames, just above Shiplake Paper Mill, 5.48 p.m., 31st May, 1873	4	28·42	0·245	0·068	0·007	0·155	0·229	1,290	1·70	15·9	7·4	23·3	0·14	0·10	0·24

TABLE VI.—RIVER THAMES. Parts per 100,000.

Place where Sample was taken.	Approximate Distance above Hampton.	Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Chlorine.	Hardness.		
									Temporary.	Permanent.	Total.
	miles.										
1883. Nov. 4. River Thames above Oxford	84	30·28	·136	·039	0	·178	·217	1·06	17·09	4·71	21·80
" River Cherwell 500 yds. above Thames	..	36·92	·305	·079	·016	·164	·256	1·44	20·86	6·29	27·15
" River Thames below junction with Cherwell	80	33·04	·158	·036	·010	·197	·241	1·17	19·43	5·57	25·00
" River Thames below Iffley lock ..	..	32·76	·165	·027	·002	·173	·202	1·20	19·16	5·14	24·30
" " " Oxford	79	31·04	·161	·031	·004	·190	·224	1·18	19·59	4·71	24·30
" " " above Reading	46	33·32	·183	·025	·007	·255	·286	1·23	20·72	6·43	27·15
" River Kennet at junction with Thames	45	27·80	·128	·036	·008	·215	·257	1·26	19·44	4·86	24·30
" " at Reading	46	29·24	·125	·030	·014	·220	·262	1·26	21·13	4·57	25·70
" " " near drain-pipe	..	30·84	·256	·074	·023	·232	·325	1·60	19·73	4·57	24·30
" River Thames just above Windsor ..	17	31·80	·224	·038	·001	·219	·258	1·32	20·31	6·14	26·45
" " at Hampton	0	30·52	·254	·047	·001	·204	·252	1·43	16·99	5·86	22·85
" 17. River Colne, branch in Staines ..	12	36·84	·318	·062	·019	·266	·344	1·45	23·7	3·4	27·1
" " main stream at junction with Thames	12	31·52	·236	·046	0	·254	·300	1·45	22·8	3·6	26·4
" River Thames above Staines Gasworks	11	32·92	·242	·035	·003	·202	·239	1·33	20·1	5·6	25·7
" " just above Staines ..	..	32·40	·230	·036	·004	·194	·233	1·40	19·9	5·1	25·0
" " just below Staines ..	..	31·12	·245	·034	·001	·209	·244	1·36	20·8	4·9	25·7
1884. Jan. 2. River Wey at Weybridge	8	20·44	·270	·085	·030	·223	·333	2·00	9·3	4·7	14·0
" River Thames at Chertsey	8	34·16	·187	·047	·014	·287	·346	1·45	20·3	4·2	24·5
" " at Hampton	0	31·92	·186	·035	·008	·281	·322	1·48	17·5	4·0	21·5
" 9. " above Windsor	17	36·68	·197	·045	·003	·193	·240	1·47	20·3	4·2	24·5
" " at Hampton	0	34·88	·227	·087	·008	·229	·323	1·52	19·1	3·9	23·0
" 13. " above Windsor	17	36·40	·291	·063	·010	·227	·298	1·50	18·8	5·7	24·5
" " at Hampton	0	33·56	·309	·055	·020	·226	·297	1·52	17·3	6·0	23·3
" 28. " above Windsor	17	28·72	·478	·098	·014	·223	·332	1·7	13·6	6·4	20·0
" " at Hampton	0	29·76	·451	·082	·024	·222	·324	1·7	13·6	5·3	18·9
" " above Windsor (average)	17	33·55	·275	·058	·008	·230	·295	1·49	18·66	5·33	23·99
" " at Hampton (average)	0	32·13	·285	·061	·012	·232	·304	1·53	16·90	5·01	21·91

NOTE.—In this Table only the dissolved organic matter is given, so as to avoid the complications arising from the suspended matters.

TABLE VII.—River Mersey, Irwell and Darwen. Parts per 100,000.

Place where Sample was taken.	Distance	Dissolved Matters.							Suspended Matters.			Temperature of Water C.
	Miles.	Total solid impurity.	Organic Carbon.	Organic Nitrogen,	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen	Chlorine.	Mineral.	Organic.	Total.	°
1. Irwell at Throstlenest weir, 12th March, 1869	11	44·6	2·104	0·248	0·230	0	0·437	7·4	1·84	0·96	2·80	6·2
2. Do. at its junction with the Mersey, 12th March, 1869 ..		43·1	2·009	0·304	0·338	0	0·582	6·8	0·96	0·48	1·44	6·8
3. Do. at Throstlenest weir, 13th May, 1869	11	39·1	2·156	0·238	0·140	0	0·353	4·9	1·18	1·86	3·04	12·2
4. Do. at its junction with the Mersey, 13th May, 1869		43·0	2·374	0·210	0·250	0	0·416	6·4	1·88	2·40	4·28	13·3
5. Do. at Throstlenest weir, 11th June, 1869, 8.30 a.m.	11	63·5	2·134	0·239	0·375	0	0·548	13·0	2·66	2·72	5·38	17·8
6. Do. at its junction with the Mersey, 11th June, 1869, 6.10 p.m.		61·5	1·502	0·241	0·413	0	0·581	12·9	2·28	1·88	4·16	17·8
7. Mersey at Stretford-road Bridge, 12th March, 1869	13	19·8	0·720	0·095	0·066	0·022	0·171	2·3	0·94	0·30	1·24	4·3
8. Do. at its junction with Irwell, 12th March, 1869		22·8	0·570	0·078	0·043	0·019	0·132	2·5	0·84	0·26	1·10	4·8
9. Darwen after junction with Blakewater, 10th March, 1869	13	41·5	2·127	0·295	0·219	0	0·475	3·6	1·78	1·78	3·56	10·7
10. Do. at Walton-le-Dale, 10th March, 1869		33·0	1·289	0·141	0·137	0·045	0·299	2·9	0·62	0·18	0·80	6·8

TABLE VIII.—River Soar at Leicester. Parts per 100,000.

Place where Sample was taken. 15th August, 1884.	Approximate distance from junction with sewage effluent.	Dissolved Matters.													Suspended Matters.		
		Appearance.	Odour.	Reaction.	Total Solids.	Ammonia.	Oxygen required to oxidise organic matter.	Organic Carbon.	Organic Nitrogen.	Chlorine.	Common Salt.	Nitrogen.	Nitric Acid.	Hardness.	Total.	Mineral.	Organic.
	feet.																
1. River Soar above Aylestone	23,000	clear	slight	slightly alkaline	59·14	0·014	0·10	0·33	0·06	2·366	3·877	0	0	38·71	..	..	..
2. River Soar and canal at Evans' Weir	7,500	clear	none	„	63·6	0·014	0·10	0·41	0·05	2·366	3·877	0	0	36·9	..	..	..
3. Willow Brook at Humberstone Bridge	8,500	very turbid	slight	„	93·6	1·829	1·33	4·12	1·601	9·566	15·676	0·24	1·07	32·1	161·7	76·0	85·71
4. Willow Brook at Belgrave Gate	4,000	slightly turbid	„	„	55·43	0·17	0·23	0·77	0·10	5·806	6·237	0	0	33·0	2·04	0·95	1·09
5. Canal above Public Wharf Lock	3,500	very slightly turbid	„	„	67·94	0·11	0·15	0·53	0·06	2·571	4·214	0	0	40·7	..	..	..
6. Canal at junction with Willow Brook	3,000	slightly turbid	bad	„	68·23	0·17	0·18	0·59	0·10	2·983	4·888	0	0	39·7	..	..	..
7. River Soar at Swan's Nest Weir above sewage effluent	100	clear	none	„	60·63	0·014	0·11	0·45	0·06	2·366	3·877	0	0	38·7	..	..	..
8. Leicester sewage effluent	0	turbid	slight	„	78·29	0·40	0·50	0·87	0·09	6·689	10·957	0	0	37·9	1·64	0·79	0·85
9. River Soar opposite Belgrave Church	2,000	slightly turbid	„	„	83·77	0·40	0·45	0·74	0·08	4·626	7·586	0	0	34·9	..	..	..
10. River Soar below Birstal (village)	11,000	„	bad	„	80·46	0·69	0·47	0·89	0·07	4·423	7·391	0	0	36·9	..	..	..
11. River Soar below Thurmaston (village)	16,000	„	„	„	85·94	0·66	0·60	1·02	0·10	2·263	3·709	0	0	39·7	..	..	..
12. River Soar opposite Wanlip Hall	22,500	„	„	„	82·0	0·69	0·59	0·96	0·10	1·646	2·697	0	0	40·1	..	..	..

Discharge at Leicester of River Soar in summer 1884. 600 cube feet per minute or 864,000 cube feet in 24 hours = 5,391,360 gals.
„ „ Willow Brook „ 40 „ „ 57,600 „ „ = 359,424 „
Total .. 640 „ „ 921,600 „ „ = 5,750,784 say 6,000,000 gals.

Average velocity of River Soar at this period, about 20 feet per minute. Volume of sewage effluent, about 8,000,000 gals. (dry weather flow) in 24 hours.

TABLE IX.—RIVER SEVERN. Parts per 100,000.

	Place where Sample was taken, January 1878.	Total Solid Matter.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Oxygen required to oxidise the organic matter.	Organic Carbon.	Organic Nitrogen.	Lime. (CaO).	Magnesia (MgO).	Sulphuric Anhydride (SO_3).	Chlorine.	Hardness.	
												Before Boiling.	After Boiling.
River Severn.	1. At Worcester Bridge above the sewer outfall	23·23	0·09	0·064	0·159	0·406	0·072	6·374	1·117	3·247	3·291	10·0	5·5
	2. Near the mouth of the sewer outfall	32·5	0·179	0·086	0·234	0·842	0·261	6·957	1·631	4·716	6·531	14·3	9·5
	3. 30 yards below the mouth of the sewer outfall	24·9	0·571	0·116	0·183	0·571	0·180	5·91	1·654	3·293	4·011	11·0	6·5
	4. 1 mile below Worcester Bridge	23·24	0·014	0·086	0·167	0·510	0·110	6·61	1·301	2·673	3·497	10·5	5·5
River Teme		19·9	0·043	0·064	0·037	0·062	0·010	7·964	0·813	2·141	0·926	9·5	4·6
River Severn.	5. ¼ mile below junction of Teme, and 2¼ miles below Worcester	19·9	0·029	0·074	0·057	0·101	0·036	7·76	0·923	2·28	1·327	10·0	5·0
	6. 4 miles below junction of River Teme, and 6 miles below Worcester	21·5	0·100	0·171	0·147	0·171	0·041	6·329	0·130	2·843	2·366	10·0	6·0
	7. 6 miles below junction of River Teme, and 8 miles below Worcester	20·4	0·100	0·086	0·137	0·180	0·035	5·76	1·157	2·794	2·366	10·0	5·5
	8. At Tewkesbury	21·6	0·043	0·071	0·139	0·212	0·018	6·069	1·501	3·657	1·989	10·3	5·5

TABLE X.—River Shannon. Parts per 100,000.

Place where Sample was taken, October 1879.	Total Solid Matter.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Oxygen required to oxidise the organic matter.	Organic Carbon.	Organic Nitrogen.	Lime (CaO).	Magnesia (MgO).	Chlorine=Common Salt.	Sulphuric Anhydride (SO_3).	Hardness.	
											Before Boiling.	After Boiling.
River at Portumna (north of Lough Derg)	24·43	0·029	mere trace	0·474	0·980	0·040	10·4	1·131	1·44 = 2·36	1·0	12·5	4·7
River at Killaloe (south of Lough Derg)	21·86	0·014	,,	0·457	0·800	0·040	8·71	1·129	1·44 = 2·36	1·49	11·5	4·2
River one mile below Killaloe ..	24·0	0·114	,,	0·309	0·480	0·036	9·43	1·544	1·54 = 2·529	1·53	11·6	3·5
,, at O'Briensbridge	24·71	0·014	,,	0·457	0·840	0·060	9·6	1·337	1·44 = 2·36	1·33	11·5	4·2
,, 1 mile below Castle Connell	28·86	0·114	,,	0·319	0·593	0·050	8·31	1·029	1·44 = 2·36	1·24	11·1	4·0
,, above the junction of River Mulcaire	27·0	0·014	,,	0·533	0·914	0·070	9·59	1·131	1·54 = 2·529	1·14	12·2	4·5
River ¼ mile below the junction of the River Mulcaire	25·57	0·014	,,	0·386	0·610	0·060	9·6	1·8	1·44 = 2·36	1·14	10·5	4·7
River at Limerick	24·67	0·014	,,	0·316	0·431	0·040	8·8	1·544	1·44 = 2·36	1·49	9·5	4·5

TABLE XI.—Rivers Ure and Ouse above York. Parts per 100,000.

Place where Sample was taken.	Distance above Intake of York Water-works.	Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia	Nitrogen as Nitrates and Nitrites.	Total Combined Nitrogen.	Chlorine.	Hardness.		Total.	Number of Colonies obtained on cultivation of one cubic centimetre of water.
									Temporary.	Permanent.		
1. Taken from River Ure above Ripon. The River Ure rises on the western extremity of the North Riding of Yorkshire, passing on its way only small towns and villages	27	24·08	0·108	0·020	0	0·075	0·095	1·1	13·4	4·9	18·3	1,800
2. Collected about 16 miles above intake of York Waterworks and about 3 miles below Boro Bridge and 10 miles below Ripon, both discharging some sewage into the Ure.	16	31·20	0·118	0·028	0	0·123	0·151	1·6	12·9	7·1	20·0	..
3. Collected from River Ouse opposite the intake of York Waterworks. Between the point of collection of No. 2 and this sample there is no town, and only one small river, the Nidd..	0	28·40	0·123	0·025	0	0·077	0·102	1·6	11·5	7·1	18·6	31,300
4. Sample of water as supplied to York by the York Waterworks	0	26·20	0·119	0·022	0	0·089	0·111	1·6	10·9	7·1	18·0	122

TABLE XII.—BLACKSTONE RIVER (U.S. AMERICA). Parts per 100,000.

Place where Sample was taken, 1887, 1888, 1889.	Distance below point of discharge of Worcester sewage.	Drainage area, sq. miles.	Discharge, cube feet per second.	Estimated Population (1888).	Population per square mile.	Number of Analyses.	Appearance, Colour.	Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
								Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates	Nitrites.
1. At the Quinsigamond Iron and Wire Works	miles. 0	63·0	161	..	..	..	..	..	..	..	..	..	..	..	..
2. At the first bridge below Quinsigamond village ..	1	63·9	..	77,500	1,213	..	0·70	23·83	5·66	18·17	0·2160	0·1218	1·19	0·0315	0·0027
3. At the dam of the Cordis Manufacturing Co., Milbury	5	77·9	212	..	..	..	..	..	..	..	..	..	..	..	..
4. At the upper dam of the Calumet Woollen Co., Uxbridge	17	145·9	370	90,900	623	..	0·40	6·67	1·48	5·19	0·1011	0·0286	0·65	0·0292	0·0009
5. At the dam at Millville, Blackstone	24	258·1	..	102,800	398	..	0·39	5·06	1·26	3·80	0·0455	0·0253	0·46	0·0211	0·0005
6. At the dam of the Blackstone Manufacturing Co., Blackstone	26	260·3	618	..	..	..	..	..	..	..	..	..	..	..	..

TABLE XIII.—CHARLES RIVER (U.S. AMERICA). Parts per 100,000.

Place where Sample was taken, 1887, 1888, 1889.	Distance from Tide-water at Water Town.	Drainage Area.	Discharge, cube feet per second.	Estimated Population (1888).	Population per square mile.	Number of Analyses.	Appearance, Colour.	Residue on Evaporation.			Ammonia.		Chlorine	Nitrogen as	
								Total.	Loss on Ignition	Fixed.	Free.	Albuminoid.		Nitrates	Nitrites.
	miles.	sq.miles.													
Above Milford, opposite wells of Milford Water Company	60·0	3·7	..	484	129	3	0·75	3·40	1·47	1·93	0·0012	0·0245	0·22	0·0063	0·00
Below Milford	58·0	12·2	..	8,230	675	..	..	..	..	..	..	..	..	..	..
At the Dam at South Natick ..	29·5	154·7	..	25,090	162	39	0·88	5·03	1·71	3·32	0·0011	0·0273	0·34	0·0081	0·0002
Just above Mother Brook ..	17·0	198·6	..	33,300	168	..	..	..	..	..	..	..	..	..	..
Just below „ „ ..	17·0	132·4	..	22,200	168	..	..	..	..	..	..	..	..	..	..
At Brookline Waterworks Pumping Station	15·0	..	..	..	..	37	0·81	5·07	1·66	3·41	0·0013	0·0254	0·37	0·0094	0·0001
At Newton Waterworks Pumping Station	12·0	140·5	..	24,300	173	..	0·75	5·22	1·62	3·60	0·0010	0·0256	0·38	0·0088	0·0002
At Newton Upper Falls	11·0	144·3	269	..	..	..	..	..	..	..	..	..	..	..	..
At Waltham Waterworks Pumping Station	4·7	181·0	..	33,350	184	..	0·69	5·62	1·70	3·92	0·0024	0·0265	0·41	0·0104	0·0002
At Aetna Mills, Watertown ..	1·0	197·8	528	57,210	289	..	0·68	6·44	1·77	4·67	0·0042	0·0290	0·53	0·0252	0·0005

TABLE XIV.—MERRIMACK RIVER (U.S. AMERICA). Parts per 100,000.

Place where Samples were taken from, &c. (15th, 16th, and 17th August, 1888).	Number of Analyses.	Colour.	Residue on Evaporation.			Ammonia.				Chlorine.	Nitrogen as	
			Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.				Nitrates.	Nitrites.
							Total.	Dis-solved.	Sus-pended.			
Above Nashua, population, 1880, 13,397	1	0·20	3·30	0·80	2·50	0·0028	0·0128	0·0106	0·0022	0·16	0·0050	0·0002
Above Lowell, „ 1885, 64,107	3	0·20	3·87	0·80	3·07	0·0022	0·0159	0·0139	0·0020	0·22	0·0073	0·0002
Central Bridge, Lowell	1	0·25	3·75	0·90	2·85	0·0014	0·0178	0·0134	0·0044	0·22	0·0090	0·0001
Below Lowell	3	0·22	4·57	1·08	3·49	0·0004	0·0181	0·0135	0·0046	0·27	0·0073	0·0003
Above Lawrence, population, 1885, 38,862	3	0·25	3·85	0·87	2·98	0·0043	0·0202	0·0152	0·0050	0·24	0·0107	0·0002
Below Lawrence	3	0·28	4·12	0·95	3·17	0·0005	0·0224	0·0159	0·0065	0·25	0·0070	0·0002
Above Haverhill, population, 1885, 21,795	2	0·22	4·37	1·07	3·30	0·0022	0·0216	0·0145	0·0071	0·25	0·0160	0·0002

The discharge of the Merrimack River at Lowell, when samples were taken, was 5000 cubic feet per second.
Distance between Nashua and Lowell about 14 miles, between Lowell and Lawrence about 12 miles, and between Lawrence and Haverhill about 11 miles.

TABLE XV.—FRAMINGHAM SUBSOIL WATER AND BEAVER DAM BROOK (U.S. AMERICA). Parts per 100,000.

Place where Sample was taken, 8th August, 1890.	Chlorine.	Ammonia.			Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
		Free.	Albuminoid.				
			Dissolved.	Suspended.			
Beaver Dam Brook, above entrance of stream from sub-soil drain	0·77	0·0018	0·0146	0·0022	0·0125	0·0001	0·0427
Subsoil drain at outlet	3·62	0·0648	0·0058	0·0000	0·6000	0·0036	0·6665
Brook 300 feet below entrance of stream from subsoil drain	2·20	0·0236	0·0100	0·0002	0·2200	0·0023	0·2586
Mouth of Brook proper, one mile below subsoil drain ..	2·02	0·0016	0·0134	0·0018	0·2000	0·0005	0·2276
Estuary of Brook, 1700 feet below its mouth	1·54	0·0024	0·0302	0·0450	0·0200	0·0019	0·1664
Estuary of Brook, 2100 feet below its mouth	1·39	0·0044	0·0286	0·0240	0·0200	0·0012	0·1214

TABLE XVI.—River Seine at Paris. Parts per 100,000.

Place where Samples of Seine water were taken.	Approximate distance from mouth of intercepting sewer, Clichy.	Organic Nitrogen or Nitrogen not yet transformed into volatile ammoniacal salts. Analysis of 1874.	Total Nitrogen, including volatile ammoniacal salts. Analyses of 1869 and 1874.	Dissolved Oxygen expressed in cubic centimetres per litre of water.	Remarks.
	miles.			cubic centimetres.	
Bridge at Ivry above Paris	18	..	..	9·50	The left branch, which is formed by the Isle of St. Denis, contains at Epinay the following: Organic Nitrogen, 0·035. Total Nitrogen, 0·150, Oxygen, 5·0 cubic centimetres.
„ de la Tournelle in Paris	14¼	..	..	8·05	
„ at Asnières above sewer outlet below Paris	¼	0·085	0·15	5·34	
Mouth of Clichy intercepting sewer	0	0·085	2·95	..	
Clichy below sewer mouth, right branch	½	0·151	0·40	..	
Clichy below sewer mouth, central branch	½	0·128	..	4·60	
Clichy below sewer mouth, left branch	½	0·125	..	..	
St. Ouen, right branch	1¾	0·116	0·20	4·07	
St. Denis right branch above sewer outlet	3¼	..	0·20	2·65	Quantity of sewage discharged into the Seine in 1874, about 100 cube feet per second.
Mouth of the Departmental sewer	3½	..	9·80	..	
St Denis right branch below sewer outlet and Croult	3¾	0·727	0·70	1·02	
Epinay, right branch	5¼	0·126	0·30	1·05	Discharge of Seine at low water 1500 cube feet per second.
Bezons, whole width of river	10	0·087	0·09	1·54	
Marly, left branch above weir	17¼	0·078	0·35	1·91	
Marly, left branch below weir	17¼	0·081	..	..	Velocity of Seine at low water about 5 inches per second.
St. Germain	18	0·076	0·22	..	
Maisons-Lafitte	22½	0·079	0·25	3·74	
Conflans (River Oise joins)	29¼	0·046	..	..	
Poissy	34¼	0·045	0·22	6·12	About 30 per cent. of the population is provided with water closets.
Triel	39	0·050	..	7·07	
Meulan	43½	0·040	..	8·17	
Mantes	65¼	..	0·14	8·96	
Vernon	..	..	..	10·40	
Rouen	120	..	..	10·42	Population 2,000,000.

TABLE XVII.—Rivers Spree and Havel at Berlin (Germany). Parts per 100,000.

Place where Samples were taken. (Samples were taken between April 1886 and March 1887.)	Approximate Distance from Stralau Waterworks.	Remarks.	Number of Analyses.	Residue at 110° C.	Lime.	Ammonia.	Oxidation of organic matter.	Chlorine.	Germs per cubic centimetre.
	miles.								
1. Stralau Waterworks (old Berlin Waterworks ..	0	Spree enters Berlin.	21	18·21	5·35	0·055	2·08	2·27	6,141
2. Oberbaum Bridge. Population of Berlin, 1,315,287	¼	In the city of Berlin.	20	18·9	6·31	0·042	1·97	2·25	8,951
3. Janowitz Bridge	1½	" " "	21	19·02	6·33	0·031	1·98	2·20	13,369
4. Friedrichs Bridge	2½	" " "	21	18·4	6·13	0·028	1·99	2·26	26,718
5. Eberts Bridge	3	" " "	21	18·7	6·37	0·037	1·99	2·24	32,983
6. Marschall Bridge	3¼	" " "	21	18·01	6·33	0·036	1·99	2·27	31,664
7. Moltke Bridge	4	" " "	22	18·9	5·99	0·040	2·07	2·20	69,323
8. Moabiter Bridge	5¾	" " "	22	19·6	6·27	0·037	2·14	2·21	50,837
9. Hafen Place, Landwehr canal	3½	" " "	21	19·44	6·30	0·115	2·21	2·46	171,000
10. Lichtenstein Bridge do.	5	" " "	21	19·4	6·42	0·070	2·15	2·39	187,933
11. Ruhlebener Lock	10¾	Below the city of Berlin.	21	20·3	6·41	0·085	2·30	2·54	234,057
12. Spandau. Spree joins Havel at this place ..	13	" " "	19	19·8	6·51	0·097	2·15	2·48	329,905
13. Pichelsdorf. Small village	15	" " "	21	19·7	5·90	0·083	2·14	2·42	189,190
14. Gatow. "	16½	" " "	20	20·3	6·43	0·069	2·043	2·47	118,882
15. Cladow. "	19¾	" " "	22	19·83	6·25	0·062	2·06	2·415	174,191
16. Sacrow. "	22½	" " "	22	19·4	6·22	0·041	1·96	2·39	9,209

Note.—The average discharge of the Spree is 1500 cubic feet per second; in times of flood the discharge has risen to 5700 cubic feet per second, whereas in periods of drought it has not been more than 460 cubic feet.

In dry weather the Havel carries a little more, in wet weather a little less than half the quantity of water flowing in the River Spree at these respective periods. Berlin purifies its sewage on irrigation farms which are nearly 19,000 acres in extent.

TABLE XVIII.—River Isar at Munich (Germany). Parts per 100,000.

Places where Samples were taken. Dates of Samples, 28th June, 21st July, and 2nd August, 1890.	Approximate Distance from Thalkirchen	Remarks.	Number of Analyses.	Residue.	Chlorine.	Oxygen required.	Germs per cubic centimetre.
	miles.						
1. At Thalkirchen. Population in 1889, 285,000 ..	0	Isar enters city of Munich	2	19·4	0·123	0·205	482
2. „ Bogenhausen. Above sewer outlet	4	„ leaves „ „	3	19·5	0·144	0·222	3,155
3. After junction with "Ice" Brook	5½	Below city of Munich ..	3	20·0	0·144	0·245	4,035
4. At Unter-Foehring (village)	7½	„ „ „ ..	3	19·6	0·124	0·226	3,143
5. „ Ismaning (village)..	11	„ „ „ ..	3	18·5	0·155	0·231	2,961
6. „ Erching „	16¾	„ „ „ ..	3	18·8	0·145	0·232	1,260
7. „ Freising. Population, 1885, 9,125	23½	„ „ „ ..	3	19·7	0·114	0·228	1,513
8. „ Moosburg „ „ 3,019	41	„ „ „ ..	3	21·0	0·144	0·229	1,109
9. „ Landshut „ „ 17,873	49	„ „ „ ..	3	22·0	0·166	0·240	909

Between points 1 and 2 one main intercepting sewer empties itself into the Isar, between points 2 and 3 the other two main intercepting sewers discharge their contents into the Isar; these two latter drain the main portion of the town.

Note.—The maximum discharge of the Isar at Munich is 11,000 cubic feet per second.
„ average „ „ „ „ 3,200 „ „
„ minimum „ „ „ „ 1,100 „ „
The velocity of the Isar at Munich is about 4 feet per second at time of minimum discharge.
„ „ „ „ 5½ „ „ „ average „
„ „ „ „ 7 „ „ „ maximum „

TABLE XIX.—RIVER ELBE AT DRESDEN (GERMANY). Parts per 100,000.

Places where Samples were taken. All the samples were taken on 15th day of April, 1891.	Approximate Distance from Bohemian frontier. miles.	Total dry Residue.	Organic matter according to Pettenkofer.	Chlorine.	Nitric Acid.	Ammonia.	Germs per cubic centimetre.
Between the frontier of Bohemia and Krippenbach	0	11·34	9·94	0·59	0·27	0·013	38,000
Below Schandau (small town)	3	12·09	8·62	0·58	0·27	0·012	38,000
„ Pirna „	16	11·71	8·56	0·58	0·27	0·012	26,000
„ Pillnitz village	21	11·69	8·20	0·58	0·34	0·011	12,000
Above Dresden, at the Municipal Waterworks	26	11·64	8·66	0·57	0·27	0·012	20,000
In Dresden above St. Mary's Bridge. Population of Dresden, 276,000	29	11·97	8·50	0·58	0·30	0·013	20,000
At Uebigau, 100 yards below the last Dresden sewer outlet	31½	12·81	8·86	0·58	0·34	0·017	38,000
At the bridge at Niederwartha, 5½ miles below the last Dresden sewer outlet	37	11·44	8·26	0·60	0·36	0·014	10,000

TABLE XX.—RIVER ODER AT BRESLAU (GERMANY). Parts per 100,000.

Places where Samples were taken. The Samples were taken in the Years from 1877 to 1881.	Total Residue.	Loss on Ignition.	Ashes.	Oxygen required to oxidise organic matter.	Organic Matter.	Ammonia.	Albuminoid Ammonia.	Nitric Acid.	Chlorine.
1. In the town of Breslau, above sewer outlets. Population in 1880, 280,000	17·23	3·90	13·67	0·44	8·73	0·020	0·024	0·072	0·80
2. " " " just below sewer outlets	53·28	17·92	35·36	2·49	49·13	1·034	0·298	0·085	2·98
3. After complete admixture, on leaving the town ..	18·56	4·28	14·28	0·58	11·45	0·112	0·042	0·098	1·10
4. 5½ miles below sewer outlets	17·90	4·33	13·57	0·44	8·59	0·048	0·033	0·087	1·04

Discharge of Oder at Breslau at low water 700 cubic feet per second.
Average velocity " " " 28 inches ".

At the time when these analyses were taken the sewage of Breslau was discharged into the Oder without any treatment. Since then a large irrigation farm of 1700 acres has been laid out, on which the sewage is now purified. The degree of purification attained is a very high one, and during the year 1890 to 1891 there was on an average 90 per cent. of the dissolved organic pollution removed.

TABLE XXI.—RIVERS NEBEL

	Place where Sample was taken.
	A.—Samples taken on 15th and 16th September, 1890.
1.	Nebel above Guestrow at Waterworks
2.	„ in the town of Guestrow about 100 yards above public slaughter house
3.	„ on leaving town of Guestrow about 100 yards below public slaughter house
4.	Sewage of Guestrow
5.	Nebel at Buetzow, 100 yards above junction with Warnow
6.	Warnow at Buetzow, about 100 yards above junction with Nebel
7.	„ „ „ below „
	B.—Samples taken from 16th to 18th October, 1890.
8.	Nebel above town of Guestrow at Waterworks
9.	„ in the „ „ about 20 yards above junction with "Town Ditch"
10.	"Town Ditch" of Guestrow about 10 yards above junction with Nebel
11.	Nebel, about 30 yards below junction with "Town Ditch," right bank
12.	„ „ „ „ left „
13.	Sewage of Guestrow
14.	Nebel in the town of Guestrow, about 100 yards above public slaughter house
15.	„ about 100 yards above sugar manufactory
16.	First effluent of the sewage farm of the sugar manufactory
17.	Nebel about 100 yards below junction with second effluent from sewage farm
18.	„ at the town of Buetzow, about 100 yards above junction with Warnow
19.	Warnow „ „ „ „ „ Nebel
20.	„ „ „ „ below „ „
21.	„ „ „ „ „ „ effluent from Buetzow Lake
22.	„ village of Schwaan „ above bridge
23.	„ „ „ below junction with Baeck
24.	„ at Rostock, about 50 yards above supply to sugar manufactory
25.	Rostock Waterworks, water at entrance into middle filter bed
26.	„ „ „ from clear water basin
27.	Unterwarnow, about 1¼ mile below town of Rostock, right bank
28.	„ „ „ „ left „
29.	„ „ 4 miles „ „ middle of river

AND WARNOW (GERMANY).

Approximate distance below Guestrow Waterworks.	Suspended Matters.	Dry Residue at 110° C.	Loss on Ignition.	Oxygen required to oxidise organic matter.	Chlorine (Cl).	Sulphuric Acid (SO_3).	Lime (CaO).	Magnesia (MgO).	Number of Germs per cubic centimetre. Not liquefying gelatine.	Liquefying gelatine.	Moulds.	Total.
miles.												
0	..	27·65	9·90	0·54	3·60	..	4·902	..	1,810	150	10	1,970
1	..	27·65	9·90	0·58	3·90	..	6·063	..	100,170	500	0	100,670
1·18	..	27·50	11·75	0·57	3·90	..	4·902	..	24,100	610	25	24,735
..	1627·00	278·60	64·60	21·84	27·50	small traces	6·45	..	56,670 not	600 reliabl	400 e	37,670
5·71	..	29·55	10·45	0·56	4·60	..	5·676	..	20,800	80	0	20,880
..	..	26·95	11·65	0·63	2·80	..	5·676	..	2,430	32	11	2,473
5·84	..	27·60	11·45	0·63	3·00	..	6·063	..	4,450	110	1	4,561
0	..	29·60	8·10	0·63	3·80	..	7·00	..	1,330	40	0	1,370
0·65	..	28·40	9·40	0·63	3·80	..	5·50	..	2,270	920	0	3,190
..	..	42·05	12·70	0·93	8·50	..	6·25	..	330,750	13,000	0	343,000
0·68	..	29·05	8·30	0·61	3·60	..	5·125	..	25,200	1,370	0	26,570
0·68	..	32·35	10·60	0·65	4·70	..	5·875	..	94,500	4,150	0	98,650
..	380·00	140·30	61·30	24·25	34·00	..	7·00	..	innu	merabl	e	
1·00	..	30·80	9·05	0·58	4·40	..	8·125	..	37,170	1,650	0	38,820
1·55	..	31·95	10·45	0·55	4·80	..	8·125	..	31,500	950	0	32,450
1·74	..	71·50	34·50	8·47	5·10	..	15·50	..	510,300	8,300	0	518,600
2·05	..	32·15	9·55	2·69	4·60	..	5·875	..	31,500	1,350	0	32,850
5·71	..	37·25	16·95	0·65	4·60	..	7·375	..	12,970	60	0	13,030
..	..	30·75	11·00	0·54	3·00	..	6·25	..	1,260	80	0	1,340
5·84	..	34·25	20·15	0·58	3·30	..	6·25	..	6,610	50	0	6,660
6·33	..	31·50	11·25	0·58	3·30	..	5·875	..	11,970	30	0	12,000
16·21	..	34·75	16·10	0·62	3·80	..	7·00	..	510	16	0	526
16·71	..	36·15	16·40	0·60	3·80	..	7·00	..	850	90	0	940
27·78	..	36·95	15·95	0·63	3·90	..	5·875	..	230	10	0	240
28·08	..	38·75	19·50	0·62	4·10	..	6·25	..	190	20	0	210
..	..	36·15	15·65	0·56	4·00	..	6·625	..	17	0	0	17
32·06	..	498·40	69·00	0·66	241·0	25·90	14·00	6·70	14,490	460	0	14,950
32·06	..	510·50	66·00	0·68	252·50	28·10	14·00	8·65	25,510	750	0	26,260
34·86	..	547·20	63·00	0·66	280·00	30·05	11·00	11·15	18,580	310	0	18,890

DISCUSSION.

Mr. G. F. Deacon: Mr. President, may I ask a question? I think it would elucidate one matter. Mr. Roechling says (p. 344), "Prof. Pettenkofer is of opinion, that if the sewage does never amount to more than one-fifteenth or 6·7 per cent. of the river water, and the velocity of the latter is at least equal to that of the former, then raw sewage may be poured into such river without causing pollution." Is it rightly expressed? because I do not quite see what the velocity of the river which contains the sewage has to do with the velocity of the sewage.

Mr. Roechling: I think the velocity in the river has a great deal to do with the pollution. If the velocity of the sewage is very great, and the velocity in the river which takes the sewage very small, then the suspended matters will on the change of velocity commence to settle down; but if, on the other hand, the velocity of the river is the same as that of the sewage, then this settling down will not take place, at any rate not to anything like the same extent.

Mr. Deacon: You are considering the question at the point of outfall only?

Mr. Roechling: Quite so, and if this settlement takes place at the outfall it is sure to go on for some way down the river.

Mr. Deacon: I supposed you were referring to the oxidisation all down the river.

Dr. Burghardt: It is a rather peculiar position—I might say an onerous one—to criticise my colleague's paper. However, I have derived very much pleasure in listening to this paper by Mr. Roechling. I have not had the pleasure of meeting Mr. Roechling before, but I hope it will not be the last time we shall meet. There is one thing I remark on page 340. He says, "To judge of the state of any river it is usual to note its state as it appears to the naked eye, and to take samples of the water for chemical, microscopical, and lately also for biological examination. In the incipient stages of pollution it is difficult sometimes to detect it with the naked eye, but when the pollution has advanced further, the turbidity of the water, its colour and smell, are sure indications of it. The chemical examination should be carried out as soon as possible after the samples have been collected, otherwise further changes in the water will take place, and it cannot be said to express the various degrees of pollution so clearly as the biological one, which gives the germs per cubic centimetre." Now I say this—and I, of course, have had a good deal of experience as a chemist and in bacteriological analysis, there is no biologist in existence who can point to any germ, ordinarily speaking, in water or sewage which he can say is dangerous, except those which are known, those of typhoid fever or other zymotic diseases which are easily recognised. They are not often in sewage water; but you can recognise them. It is so very rare, and it seems so very unnecessary to look for those germs in sewage which you are not going to drink, that it seems a waste of time. We will assume that the sewage is purified, and that you are going to submit it to biological examination. You will find bacteria—you will find them in all water, even the deepest well water. They are necessary; there are only a few which are objectionable. I say, as a scientific chemist, will you point out which are objectionable and tell me how you are going to destroy those without destroying the myriads of others which are useful? If you cannot do that, then I say leave it alone. The biological method is very useful for recognising the germs in water for drinking purposes. In drinking water you will find the germs are countless, they have been counted up to 329,000 per cubic centimetre. Will you say which is the particular microbe you have got to eliminate? Otherwise it is quite useless. With regard to sewage in the river, personally I am inclined to agree with the conclusions of Drs. Letheby and Tidy, and I most strongly disagree with the conclusions of the Royal Commissions. I have not the least hesitation in saying of Lancashire rivers, give them a fair chance and they will purify themselves in three or four miles. If you, however, load them with a vast mass of manufacturing sewage, the refuse of dye and other works, you prevent the oxygen getting at the ordinary sewage, which is more oxidisable than manufacturers' sewage, and the river cannot purify itself with the flow. Give it a chance and I believe it is quite possible, with the fall we have in the river Irwell, that it will clear itself. I agree with Drs. Letheby and Tidy that given a good flow, a good deal of the sewage will be taken out of the river. Of course Dr. Pettenkofer is a great authority on the subject, but I do not think it is necessary to go to Munich for experience of polluted rivers, because we have got them in our own districts. We ought to know as much about river pollution as any one; if we don't we ought to. I was very pleased with Mr. Roechling's paper, and I think he has done good service in bringing it before your notice.

Mr. H. Alfred Roechling (Leicester): In reference to what Dr. Burghardt has said as to the biological examination of water, it is quite true that we have not yet penetrated so far that we are able to say with absolute certainty what germs found in a water are harmless and which are harmful; but a great number of investigators are at work in all parts of the globe, who push their conclusions further and further almost every day, and there is ample ground for believing that it will not be very long before we have fathomed what is at present to some extent still shrouded in darkness. Meanwhile, we have to be content to ascertain, quantitatively as it were, the number of germs present in any water, and here it has been demonstrated over and over again, and can be stated without fear of contradiction, that the greater the purity of any water the smaller will be the number of germs found in it. From the number of germs found in a water we can, therefore, form an opinion of its purity, and this surely is worth knowing, though we have not yet got beyond it, and are not yet able to point out what is the life-work of each germ found in it.

I am further of opinion that the biological examination gives a more vivid picture of the changes a water undergoes than the chemical analysis. I will give a few figures to prove this. In the case of the Spree at Berlin the oxygen required for the oxidation of the organic matter amounts to 2·08 parts per 100,000 at the old Berlin waterworks, where the river enters Berlin, and at the worst point this amount has only risen to 2·30 parts, or about 11 per cent., whereas the increase in the number of germs per cubic centimetre from the best to the worst point of the river has been from 6141 to 329,905, or about 5272 per cent. As this increase has been fairly gradual, there can, therefore, be no doubt, that the biological examination presents in a far more striking manner the changes the water of the Spree has undergone between the points in question than the chemical analysis.

With reference to the opinion on sewage farms expressed in Dr. Burghardt's paper, I would like to remark that I differ very widely from it. I had the honour in the spring of this year to read a paper on the "Berlin Sewage Farms" before the Institution of Civil Engineers, for which the Council awarded me a Telford premium. In this paper I have given a full account of the very extensive sewage farms of Berlin, which have now reached a total area of about 20,000 acres, and are being extended from year to year as circumstances require it. I have carefully examined what has been done in the way of sewage purification by the various artificial (chemical) processes, and by the only natural one of sewage irrigation, and have come to the conclusion that the land has done far more in this respect than any chemical yet employed. In the discussion which followed the reading of the paper, the two chemists, Dr. Dupré and Mr. Dibdin, who are the authors of the present chemical treatment of the Metropolitan sewage at Barking and Crossness, and who have given this question a vast amount of attention, frankly admitted that where suitable land could be found the method of sewage irrigation was the best. I have prepared a table showing the results obtained from the various methods of sewage purification, which, with your permission, I will read out:—

A. English Effluents.	Average Percentage of Dissolved Organic Pollution removed.	
	Organic Carbon.	Organic Nitrogen.
Chemical processes, average results ..	28·4	36·6
Upward filtration, average results	26·3	43·7
Downward intermittent filtration, average result..	72·8	87·6
Irrigation, average result	68·6	81·7

C. Berlin Effluents.	Average Percentage of Dissolved Organic Pollution removed.	
	As expressed in Parts of Permanganate of Potash reduced.	Organic Ammonia.
Broad irrigation: Grass plots, average of 71 samples	93·89	98·15
Filtration: Beds, average of 76 samples..	92·56	97·72
Filtration: Tanks, average of 36 samples	82·60	94·83

The figures referring to the English effluents I have taken from the first report of the Rivers Pollution Commissioners, and, I think, there can be no doubt that land has better purified the sewage than any of the rival methods. As to what Dr. Burghardt remarked concerning the spreading of the germs over the land in sewage farming and the evil consequences following upon such wholesale distribution of micro-organisms, I would say that nothing of the kind has taken place on the Berlin farms. After having given careful statistics concerning the cases of sickness and death on the farms, I sum up as follows: "The author is aware that the population to which the above statistics relate is very small, being only 7899 persons in the aggregate, and that the period of five years is a limited one; but he is of opinion that if the above rates mean anything at all, they must be taken as indicative of the healthy conditions of life on the Berlin sewage farms. Nearly every report mentions that in no recorded case of death was it possible to trace that it had any connection with sewage farming, and the report for 1888–89 contains this remarkable passage: 'Especial stress must be laid upon the fact that not one case of typhoid fever (typhus abdominalis) has been recorded during the year upon any of the farms, though the eastern and northern portions of the city were visited at the commencement of the year with a severe outbreak of this fever, this being the first epidemic of any extent since the establishment of the farms.'" Four convalescent homes, with an aggregate number of 286 beds, have been established in the very centre of the various farms, and are supplied with water taken from wells sunk on the spot; this could not have been done had the conditions of life on the farms not been essentially healthy, and, as I stated before, the farms have had no ill effects whatever upon the health of the population living on them.

I am fully aware that several sewage farms in this country have been a failure, but this is due in some cases to bad management and not to the land. A sewage farm is more difficult to manage than chemical purification works, as the chances of failure by the former method are greater than by the latter. I think I have proved conclusively that sewage irrigation need by no means be a failure, and that if well managed, land purifies the sewage better than any chemical process yet invented. But with the permission of the meeting I would like to read the concluding sentences of my Berlin paper, which are as follows:—

"Much has been said and written for and against sewage farms, and the question whether chemical treatment or application to land is the better way to dispose of sewage has been fiercely discussed. The battle is still raging, though its din may perhaps be a little more distant, the public at large having grown weary of arguing this matter with no apparent likelihood of arriving at a satisfactory conclusion. The author is of opinion that there can be no general solution of this vexed question, and that a great mistake has been made in the past by over-zealous advocates of the one or the other method, each party considering their own remedy to be an unfailing one in every case. These enthusiasts have thought that a success obtained in some particular case under special conditions could be anticipated under all circumstances, forgetting that like causes may not produce like results if the conditions under which they have to work are not the same. The question is not so much whether sewage farming or chemical treatment is theoretically the right way to dispose of town sewage, but rather whether in a particular case the one method is more likely than the other to give good results, as every case requires to be dealt with on its particular merits."

Mr. J. Lemon: Mr. President, I think it was a rather clever thing on your part to pitch one Professor at the other, but I do not think the result has been so satisfactory as you expected. Still I am happy to say there is some agreement between these two learned gentlemen, and that is, curiously enough, contained in the last paragraph of their papers. Dr. Burghardt says, "It is not possible to say dogmatically that this or that process of sewage treatment can be universally adopted. Each district or town has very likely some distinct characteristic either in the composition of its sewage, in its climate, geographical position, geological conditions, or other cause which must be considered carefully before deciding upon such a very serious and often expensive undertaking as the disposal and treatment of its sewage by any process." Mr. Roechling says very much the same thing. That is as far as we have got at the present day; and I think I may prophesy—though they say you should never prophesy unless you know—and say it is as far as we shall ever get. The sooner the members of our profession give up the idea that there is a universal method by which sewage can be purified, the better. You must adapt yourselves to local circumstances, and unless you do that failure will be the result. We heard last night something about the beauties of Bury. I do not wish to criticise after-dinner speeches, but curiously enough, not a word was said about the River Irwell. Neither Alderman Maxwell nor Mr. Webb said a word about the river; but perhaps that is to come. Sometimes it is necessary we should see ourselves as others see us, and if the result of our visit to Bury will be to wake up the local authorities to do something for the River Irwell, I do not think our visit will be in vain. We have been told that if we give the rivers a fair chance the rivers will look after themselves, and that sewage is more oxidisable than the manufacturers' refuse. The question I want to put is, Has the River Irwell ever had a fair chance? Another question is, What is the County Council of Lancashire doing to allow this to go on? The pollution of rivers is a very serious matter, and I think some action should be taken to purify the River Irwell. There is really no difficulty in the matter; it is all a question of cost. Perhaps that is where the shoe pinches. When we want to get rid of any nuisance we are always told it is very expensive. But that ought not to stand in the way. I look upon a river as a public highway, and you have no more right to turn refuse into a river than into the streets. The sooner it is looked upon in that light the better it will be for all parties. I think it would be an improvement, if it could be done, if these papers could be sent out some weeks before the meeting so that we could come prepared to discuss them. I am not a sufficiently good chemist to discuss them off-hand. This I will say, they are most interesting papers, containing very valuable facts, and all are much indebted to the authors for preparing them. I have, therefore, much pleasure in moving that the best thanks of this Association be awarded to Dr. Burghardt and Mr. Roechling for their very interesting papers.

Mr. H. J. Clarson: I have very great pleasure in seconding the vote of thanks to Dr. Burghardt and to Mr. Roechling for their valuable papers. I am particularly interested in the question of rivers pollution. Unfortunately, I have in my district 12 miles of one of the worst polluted rivers in the country—the Tame. We have a scheme before the Local Government Board now for the removal of the weirs. It has always been my contention that if we could increase the velocity of the rivers we should improve and help to purify them to some extent. You will understand the sluggishness of the river I am speaking of, when I tell you that there are six weirs in the 12 miles with an aggregate height of 26 feet. Into this sluggish stream we have flowing the effluent from Birmingham and the other towns above. Analyses of water which I have taken from the river at various parts show 154 parts per 100,000 of solid matter. This will give you some idea of the fearfully polluted state of the Tame. The County Councils of Staffordshire and Warwickshire have endeavoured to act jointly with the object of doing something to remedy this wretched state of things, but so far nothing has been done. At a conference at Wednesbury the other day the Earl of Harrowby, the chairman of the Staffordshire County Council, said it was the intention of that Council to insist upon every local authority in the county keeping their river in a pure condition. Fifteen years ago this river was a clear pellucid stream, but now it has grown up to one-half its actual width, as a result of the pollution. My plan is to remove the weirs and to dredge the bed of the river. Unfortunately the Local Government Board tell us they cannot lend the money to dredge the river, and if that dredging is done it will have to be paid out of the current rates. As the work proceeds from time to time in my district I shall be pleased to supply the Association with all the information in my power, and I trust that so important a question as that of rivers pollution will not be lost sight of by this Association. I hope that facilities will again be afforded for discussing this subject.

Mr. A. M. Fowler: There is no doubt the velocity of a stream greatly improves its sanitary state. For instance, in the town of Leeds the streams were very seriously polluted by all kinds of refuse being thrown into them, but by narrowing the stream, and deepening the centre of the bed, the refuse gets away so rapidly that the nuisance ceased to exist. Of course those streams go into the main stream—the River Aire. It is during a time of drought that the bed of a river becomes impregnated with filth, and it is when the first flush comes that the fearful nuisance arises. There is no doubt you do not expect to drink sewage, but when you turn a stream of sewage into a large river you are liable to drink it. Take the case of Leeds and the River Aire: the Corporation of Wakefield formerly pumped the water of the Aire for the supply of the town. Can you tell me there were no germs of typhoid in that water? When Sir Isaac Newton poured a strong light into a dark room the prism of light showed that the atmosphere was choked with filth and dirt. It is all very well to shut your eyes to these facts, but the germs of typhoid are there alike in water. You may take a thousand samples of water and miss the germs of typhoid. If this is so it is no test that the germ of typhoid is not there. Therefore it is not fair to attack Mr. Roechling in that way, and I contend on that ground that his theory is quite right. Of course you take my argument for what it is worth. With regard to the purification of sewage, my experience with that subject has been since

1869. We then heard a great deal of these beautiful theories of different chemists. We then went all over England to see if there was a process to suit Leeds. The Corporation spent 10,000*l.* in experiments before putting down permanent works. We first let our works to the A.B C. Company with a strong agreement which bound them down hand and foot. They were soon very glad to get out of it and to give the Corporation the right to use their patents if they desired to do so. We have plenty of precipitants: we have plenty of chemical mediums to purify our sewage, but it is the cost which it is desirable to reduce. Sulphate of alumina and lime will purify our sewage and give a very good result. They get a very good result at Leeds to-day with lime. They advertised some years ago to all the world that they were willing to allow any one to experiment with the treatment of the sewage. The Corporation said, "You may treat the sewage as you please, but we shall put an independent chemist on to weigh and check your chemicals." By this means they found out that the statements as to cost were not borne out. If any chemist can give us a cheap precipitating medium we shall be only too glad to adopt it; but we cannot adopt many of the present systems because of the cost. This is the case at Leeds and at Salford. In my designs for the Stockport works I have in this respect been in some little difficulty as to the mode of treating the sewage; but I think we shall have tanks and put the effluent therefrom through the land. I was going to say one word about the purity of the water and the A.B.C. process. With the A.B.C. process at Leeds we had fish living three weeks in a globe filled with sewage water; and a second in a globe supplied by the town's water changed three times a week, and one of the fish in the town water died three days previous to one in the sewage water. It is on record, so there is no dispute about it, and will be found in a paper which I read before this Association eighteen years ago. Now as regards polarite, because that has come very prominently to the front of late. If the diagram proves that the ferrozone does not precipitate the solids in the same proportion as the other processes, does it not follow that the effluent is the greater tax on the filtering medium? The process shown us at Acton was not of sufficient duration to prove to me that the filter bed would take the effluent water. The filter bed was in my opinion choking up. With clear water you cannot get more than 700 gallons per square yard through the filtering medium, and how can it be expected that the polarite prospectus can be realised, when it professes to put more sewage water through the filter bed than ordinary town's water? I desire to offer my thanks to the authors of the papers for their interesting and valuable contribution.

Mr. G. F. Deacon: I feel strongly the great value of the two papers just read, but there cannot be a doubt that if they had been in our hands some days at least before the meeting they could be much more usefully discussed.

As regards the purification of sewage after its discharge into a river we know exceedingly little, and as to the destruction of specific germs we know still less. The records of different observers and different rivers are in the highest degree conflicting, and while so little notice is taken of the enormous difference of volume discharged by each river at different times, they must always be so. Those differences are so great that even in low-land rivers the volume of flood discharge often exceeds the volume of extreme dry weather flow in a unit of time by many hundreds of times.

The present state of our knowledge tends to the belief that if the flow of a given river were uniform throughout the year, and if the observations were not disturbed by affluents constantly changing the proportion between the river water and the sewage it contains, the rate of purification would be very slow indeed. On this hypothesis the bed of the river would soon after its creation acquire a stable regime, deposition and scour would be exactly balanced, and the action known as sedimentation would not exist. The weight of particles, whether organic or inorganic, crossing one section of the river in a unit of time would be precisely the same as the weight crossing another section, except in so far as decomposition and evolution of gases had taken place. As to the rate of this disappearance of organic matter by evolution of gases we know very little. If such exceedingly uniform and uninteresting rivers existed in nature we might determine that rate, and we might answer moreover the far more important question how far the micro-organisms originating with the sewage survived the destruction of the sewage. What we do know is that during the period of sedimentation which takes place with a diminishing flow of the river micro-organisms are carried down with the sediment to the bottom. Directly the flow is increased scour begins and attains its maximum in great floods. Throughout the rise of the flood, and in a reduced degree during the early part of the fall, the sediment containing the micro-organisms is lifted up and carried along. In order therefore to investigate the pollution of a river we must examine it in all conditions of flow. Happily the worst condition, viz. that of a rising flood, is relatively very short.

As regards methods for the disposal or purification of sewage. I confess I am not prepared to agree with the author of the first paper in his sweeping condemnation of broad irrigation or intermittent downward filtration. By the latter treatment properly applied very remarkable results may be obtained. Everything depends upon the nature of the subsoil, the drainage, and the management. The bulk of the crops must be secondary to the degree of purification, and too often this is not the case.

For great centres of population I am, however, inclined to agree with the author that chemical treatment may prove to be necessary.

Mr. T. W. Stainthorpe: I will in a few words give you my experience of the results of river pollution in my district, where we have had a very severe outbreak of typhoid fever. The Teesside district receives its water supply from the River Tees at Darlington, which supplies the whole of Teesside from Darlington to Redcar. Eighteen months ago we had a severe outbreak of typhoid fever. It was so alarming, and the death-rate was so high, that all the authorities decided to ask the Local Government Board to investigate the cause. Dr. Barry came down and held an inquiry, and his report clearly proved that the outbreak of typhoid fever was owing to the pollution of the River Tees at Barnard Castle, about 17 miles higher up the river than where the water is obtained. I do not think that agrees with the statement of Dr. Burghardt, the author of one of the papers, that there would be no danger of typhoid germs. Outside the district supplied with the water there was not a single case of typhoid fever, although the district is alongside that supplied, and the people are living closely together, so that it clearly proves the polluted water to be the cause. The death-rate at that time was very high indeed. They are now carrying out an extensive scheme for obtaining a pure supply five miles above Barnard Castle, which is about 35 miles from my own district.

Dr. Burghardt: It is an entire misunderstanding of what I said as to germs. I never said that water which had typhoid germs in it would ever cease to have them in. Whatever the length of flow I do not think it would destroy typhoid germs. I was not speaking of germs. It is the organic matter—the oxidisable matter—which would be destroyed by the flow of a river; germs are not destroyed by the flow of a river. You can trace them out and destroy them in some other way, but flowing down the river will not destroy them at all. There is another thing about the biological examination of the germs. I say there is an enormous number of germs in all waters. It is necessary to know if there is one germ in the water that is poisonous; if there is, do not touch the water. If you find such germs where sewage water might be drunk, then I should certainly condemn the water. Where you have a water swarming with bacteria, and you discover no poisonous germs, then I say you cannot absolutely condemn the water. I am very sorry that Mr. Fowler and Mr. Stainthorpe misunderstood me.

Mr. Stainthorpe: I certainly understood you to say so.

Mr. Fowler: You say you do not expect to find germs in sewage which you do not expect to drink.

Dr. Burghardt: Of course if you drink sewage you must expect to find them. There is another matter about the sweeping condemnation I am accused of making against intermittent filtration. I say in my paper at p. 309, "For large towns in populous manufacturing districts, such a plan of sewage treatment is quite impossible on account of the enormous area of land which would have to be acquired for the purpose, it being understood that not more than the sewage from about 400 people should be drained upon one acre of good filtering land." You can form your own opinion as to where the land is to come from if you have to treat the whole of the sewage of Lancashire by land filtration. We must have some other means of treating the sewage of our large Lancashire towns.

Mr. W. Dyack (Aberdeen): We are at present engaged in a fight with the County Council, and it was with the object in view of possibly getting information on the question of river pollution that might be of use to us that I attended this meeting. I may explain just briefly that our water supply in Aberdeen is taken from the river Dee at a point 23 miles away. There are four villages which at the time the works were designed were very small places. But they have since largely increased, especially during about three months in summer when they are favourite places for summer resort, and the degree of pollution has thereby increased, and that at a time of the year when the river is at its lowest. I may say, in coming to this part of England, we cannot show that amount of pollution in our river Dee such as you have in the Irwell, and if you were to see the Dee you might think we were rather fighting a shadow in taking extreme measures, yet we hold that as regards the purity of the water supply we cannot be too particular. We have engaged the services of Dr. Frankland, Dr. Hill, of Birmingham, and other experts to give evidence, and we are determined to spare no effort or expense to maintain the purity of our water supply. The Scot is famed for his canniness, but I am afraid you will hardly credit it when I tell you this instance of it. We met the County Council, and we made them an offer whereby we would relieve the villages of the cost of laying out irrigation farms, and relieve them of all cost of working, if they would provide us with the necessary land, which we pointed out, and bring the sewage to that point, and, would you believe it, they absolutely declined. We think that was a very fair offer to make to them, and I am sure if it were proposed in any part of England it would be jumped at. We hold that in the case of these villages the sewage systems of which were established subsequent to 1876, that they are not entitled at all to put sewage into the river after that date. There appears to be something in the Act which requires explanation in the case of these towns, as the river being the natural drain of the district these towns must have their sewage treated in some way, I presume, and the effluent must ultimately go into the river. I shall be obliged if any gentlemen can give me any information as to this particular clause of the Act. There is also another point I would be glad of information on, with regard to keeping the rivers pure. We have been thinking not only of the increase of these villages, but houses are continually being built on the banks of the river, so it makes it a most difficult matter to deal with. The County Council in Aberdeen grinds exceedingly slow, and it is a most laborious process to do anything through them; and it has occurred to us that it might be possible to establish a sort of Conservancy Board to take steps to maintain the purity of the river, to purchase land and establish works for the treatment of sewage and the general purification of the river.

Dr. Burghardt, in acknowledgment, said: It has been an exceedingly great pleasure to me to gratify your respected President. I have known him for many years, and I hope I shall have the pleasure of meeting him here for many years more. It has also been a great pleasure to me to come to this good old Lancashire town of Bury.

Mr. Roechling: The question of the biological examination of water is to my mind so important a matter, and is so frequently only imperfectly understood or altogether misunderstood, that I should like to give in a few remarks the general bearings of it.

Broadly speaking we must distinguish two separate and entirely distinct stages in the development of the theory of fermentation. The first stage, practically, was Liebig's theory, that fermentation is brought about by organic matter imparting alteration and decay to other organic matter, with which it is brought in contact; thus he held that ordinary alcoholic fermentation is brought about by the dead yeast cells undergoing decomposition and not by the living and growing yeast. The second stage is Pasteur's theory that fermentation is brought about by living organisms and not by decomposing organic matter. Pasteur also showed that living organisms are the cause of some and probably all the zymotic diseases. It cannot be surprising that as long as Liebig's theory was the adopted doctrine of the day, chemists only paid attention to the organic matter as being likely to cause injurious changes when consumed in water in the digestive organs through which it passed. But Liebig's theory has passed away and to-day Pasteur's doctrine is universally held. It is to germs that we attribute some if not all the zymotic diseases, and bitter experience has taught us that these germs can be distributed by means of a polluted water supply and cause sad havoc amongst populations. For us, therefore, are the living organisms in water—the organised organic matter—of primary importance, and the organic matter devoid of life, anorganised organic matter, only of secondary importance as affording indirect evidence of the presence of micro-organisms. Although this was generally admitted, no means existed for some time after Pasteur had established his theories, to examine water biologically, i. e. for micro-organisms, and during this period, chemists had no other choice but to concentrate all their efforts in detecting even the minutest quantities of anorganised organic matter, as water which is devoid of this, the food of the micro-organisms, would not contain the organisms themselves. Since then, but not until a few years ago, and especially through the efforts of Dr. Koch of Berlin, methods have been found which afford direct evidence of the presence in water of the organised organic matter, the germs. It cannot be surprising to find, however, that these methods have had to run the gauntlet of a strong adverse criticism, but the opposition to them is gradually dying away, and it is perhaps not too much to say that in a few years hence they will have found universal application.

If, as I have shown in the case of water, the biological purity is of greater importance than the chemical, it is also so in the case of sewage, and no examination of a sewage effluent can be considered complete which is confined to a chemical analysis only. In any sewage treatment we must aim at freeing the sewage of its most dangerous constituents, otherwise the whole treatment has no sense, and, surely it must be of much greater value to ascertain the extent to which this has been done by direct evidence than by indirect. I do not suppose for a moment that any one would be foolish enough to drink a sewage effluent as it leaves the purification works, but the effluent may go into a stream from which a water supply is drawn, as is the case with the Thames and Lea.

With regard to the very interesting remarks of Mr. Deacon concerning the influence of floods upon the state of a river, I would say that observations on the rivers Spree and Isar tend towards the following conclusions:—

1. That the average number of germs found in the water of a river is greater during periods of low water than during periods of high water.

2. That a sudden downpour of rain increases the number of germs in a river.

It does not follow, however, from these observations, that this increase is due to the germs deposited on the river bed having been stirred up by the increased scour; it would rather appear in the main to be due to a vast number of germs having been washed off the surface of the roads, streets, &c., into the sewers and thence into the river. It is an established fact that the number of germs living on the decomposing organic matter scattered about our roads is very great.

There is not much evidence to show what becomes of the germs that disappear and are carried down to the bottom of the river in its onward course, but I think I interpret correctly such evidence as exists, when I say, that as a rule they cease to exist.

In conclusion, I should like to say it has given me great pleasure to read this paper before you, and I trust I have added, even if it be only a little, to your knowledge concerning what is of vital importance to all of us.

CORRESPONDENCE.

Mr. **Wm. Spinks**: I quite agree with the remarks of Mr. Deacon that there should be more combination between the engineer and the chemist, for this reason, that no two places are exactly alike. In Lancashire the trade effluents turned into the sewers are entirely different from those turned in in the towns of the West Riding of Yorkshire. Again, the quality of the effluent varies from day to day; on the early days of the week there is a preponderance of soapy water from the domestic wash-tub. For these, amongst other reasons, I consider that daily samples of the sewage, showing its mean condition, should be taken over a whole year and analysed, so that the quality and quantity of the precipitant may be determined as well as the nature and extent of the media to be used for filtering the effluent before it is passed into the water-course. Referring to Mr. Roechling's paper, I hardly think a fair test has yet been applied to river waters so as to ascertain their exact quality throughout the whole of their daily flow. About this time last year I was engaged along with Mr. Wm. Thomson, F.R.S.E., F.C.S., &c., in an investigation into the condition of the River Irwell in Manchester, and although in taking samples of the water we dragged the bottles from side to side of the river and at the same time gauged the flow, we felt we still had not got a fair result, and the conclusion we came to was that in order to do this a tank should be erected say to hold a three hours' supply by a 1 inch pipe connected to a floating arm outlet in the river, or some other automatic contrivance. When the tank is filled its contents should be agitated and the samples collected, care being taken to gauge the river at this point every three hours. There are many other things which also require observing, such as the variations of discharges of the trade effluents into the streams and the velocity of the current.

Mr. **F. S. Button**: I thank Dr. Burghardt for his instructive and valuable paper; it is of great interest, and will rank in the first class in the 'Proceedings' of the Association.

His condemnations of irrigation and sewage farming and intermittent downward filtration are, I think, too severe. The system to be adopted for the disposal of the sewage of towns depends entirely on local conditions, and as no fixed rule is applicable to all places, each town must be provided with a system best fitted to itself.

It has been proved in several cases that both broad irrigation and intermittent downward filtration of crude sewage have resulted in effluents sufficiently pure to be turned into streams.

The success of the systems undoubtedly depends on the area and quality of the land so utilised, and on intervals of rest for perfect aeration of the surface, so as to fit the soil for its work. One great drawback to obtaining satisfactory effluents, not only from irrigation, but also from precipitation works, is the lack of due attention to management of working, and an idea has prevailed among local authorities that once the works are completed and ready for use, the great work is done, and no further special care need be bestowed upon them, hence unsatisfactory results and condemnation of the system in use.

In my own town (Burnley) the lime process has been tried for several years, and has been proved a failure, as although an apparently pure effluent may be obtained from the process, secondary decomposition has taken place, and manifested itself in the stream into which the effluent is discharged.

This process is now about to be modified by the use of a small quantity of aluminoferric, in addition to lime, as precipitants, and the further treatment of the clarified sewage by intermittent downward filtration through specially prepared areas of land which have a light loamy subsoil.

These areas are now nearly completed, and a satisfactory result is anticipated.

Dr. Burghardt in his paper says: "Sewage sludge must be considered an unavoidable nuisance, to be got rid of in some way or other," and also that "the only good way is to place it upon a suitable plot of ground, hard underneath, and inclined towards a catch-pit or tank to retain the foul drainings." I agree with the first statement, but I entirely disagree with the second. My experience has been that air drying of sewage sludge on underdrained pits is but a sorry way of treating it, and that any method at present known other than that of pressing in filter presses is most offensive to the eye, and also an abominable nuisance.

Ordinary wet sewage sludge contains approximately 90 per cent. of moisture, but by the use of filter presses it can readily be reduced to a portable manure containing 50 per cent. of moisture, in one hour. Exposure of wet sludge to the air on underdrained pits would not effect an equal reduction in twelve months, unless the sludge deposit was thin, and consequently the area of sludge pits must be enormous to receive the deposits from the sewage of say 100,000 persons. I know of nothing more objectionable than the sight of masses of foul wet sewage sludge, and if exposed to rain and the heat of the sun in summer time, a great nuisance is created. At the Burnley works I have three forty-chamber presses which can reduce 100 tons of wet sludge to 20 tons of pressed cake in one day, the average weekly output from the settling tanks being 450 tons of wet sludge.

This process is carried on without any nuisance whatever, the system is orderly and clean, and no difficulty is experienced in getting rid of the pressed sludge; in fact, at the present time there is not 20 tons in the store shed. Dr. Burghardt attaches very little value to sewage sludge as a manure, but experience in this district extending over several years has proved it to be valuable, in fact much more so than ordinary stable or farmyard manure. Some farmers in this district have used it for several seasons, and speak highly of it, and I am sure the simple fact that some of them come a distance of five miles for it, year after year, is some evidence that pressed sewage sludge is valuable as a manure.

Dr. Burghardt writes in reply: I have dealt with everything Mr. Button mentions in the paper. The only thing in which he really has pointed out a flaw is on page 324, where I deal with the disposal of sludge. I quite agree with him that the heap or stack of draining sludge on the inclined floor ought to be covered over in order to protect it from rain. There will be no nuisance if iron salts are used to precipitate the sewage. The sludge will not be foul in that case, lime-sludges are always very foul. With regard to the Burnley farmers sending five miles for the sewage sludge, I can only regret their ignorance and credulity. Besides Burnley is a peculiar place, the only land available for farmers being grass land and very little other. I also quite agree with Mr. Button that pressing sludge by machinery is the very best preliminary treatment of it, *in large towns* and places where they can afford such machinery; where they cannot, the sludge must be drained in some such manner as I point out, and dried afterwards.

UTILISATION OF WATER-POWER.

By HERBERT G. COALES, Assoc. M. Inst. C.E., Engineer and Surveyor to the Market Harborough Local Board.

It has occurred to the author many times that the utilisation of water-power has not received the amount of attention at the hands of the Association to which it is entitled—indeed he can find no paper bearing upon the subject. By placing a few notes before you it is hoped that the recital of your experience and suggestions may be conducive to the further utilisation of water-power in the service of our towns and districts. The author casts the responsibility of this paper upon the Association, because no more experienced Member has hitherto introduced the subject.

In using the term water-power it must not be understood that of itself water has any power—any more than a spindle has—but it is necessarily acted upon by the energy of gravity, and being practically incompressible, is capable of transmitting power. It is only in this sense, therefore, that the term is used.

If municipal engineers would take the trouble to investigate the available amount of water-power in their localities, for the purposes of applying it for the benefit of their districts, probably not a little advantage might be gained in many directions. Members of this Association who have already requisitioned water-power for municipal engineering, would confer a great benefit on some of us by narrating the details and efficiency of such work.

Our subject has practically nothing to do with the application of machinery to water, but that of water to machinery, except in so far as reference is made to hydraulic mains, having an artificial head caused by the pumping of water under a load into mains, which in turn are to be used for motive power.

Doubtless a convenient course will be to classify the subject under three heads:—

I. Sources of energy.
II. Water motors.
III. Application of power.

I. SOURCES OF ENERGY.

Water is a source of energy which, unlike that of coal, is unaffected by strikes ; neither is it a power which is ever likely to be more limited than it is at present.

Vapour having been raised by the sun's heat, clouds are formed at various distances from the earth's surface. The rain falling from these clouds provides a power which it is the privilege of man to utilise. The higher the elevation of water above the sea-level, the greater the source of energy obtainable. When we consider that falling water is capable, theoretically, of performing just the amount of work which would be required to raise it to the height from which it has fallen, we can understand what an enormous available power exists in nature for the working of machines. When water falls freely its descent will be accelerated in the same manner as that of falling solid bodies. It is, nevertheless, seldom that direct advantage can be obtained from this law, as most of the water falling upon the earth's surface, sooner or later, finds it way to channels and streams, the inclinations of which are flat and the beds rough, causing great friction.

Wherever there is water there is power, and if we remind ourselves that about 3000 tons of water fall on every acre of area in England per annum, we see that it is no insignificant power, which it is our duty to impress into the service of man. Evidently only a proportion of this water can be profitably employed as a motor, as the falling rain has to serve other purposes in nature. But on the other hand water can be used over and over again, being unlike steam in this respect, which on leaving the cylinder is evaporated. Perpetual motion is a demonstrated impossibility, but in a constant supply of flowing water, as in some stream which is never dry, we approach very nearly to the long sought-for discovery.

It has occurred to the author that besides the power to be obtained from rivers, streams, waterfalls, lakes, tides, &c., small motors might more generally be driven from the water mains, sewage water, storm water, &c. In Market Harborough, the pressure in the water mains is sufficient for working such machines as hydraulic lifts, there being a head of 200 feet. This head is not sufficient for giving a proportionate efficiency as compared with steam for all purposes, but such a head might be utilised where the employment of other generating power would be out of the question.

Mr. J. W. Sutcliffe, in the 'Proceedings of the Institution of Civil Engineers,' says, "Every square mile of freely-drained area of watershed in this district (E. Lancashire and W. Yorkshire) will furnish 0·2 H.P. per foot of fall (with very little storage), except during a few weeks in summer, when steam machinery is in its state of maximum efficiency."

To take the greatest known source of water-power in the world, we are told that the River Niagara has a total descent of 334 feet, and discharges about 40 millions of tons of water per hour; giving a horse-power of over 15,000,000—a power which it is difficult to conceive.

At Bellegarde, at the confluence of the Rhone and the Valserine, on a fall of 40 feet, 3700 H.P. are utilised by six turbines.

With respect to tidal power, the resultant opinion of a discussion at the Yorkshire College Engineering Society appears to have been that it had been somewhat over-estimated. The greatest possible advantage derivable from each acre of water 10 feet deep, reckoning a working day at eight hours, was stated to be $3\frac{3}{4}$ H.P.

An example of unemployed water-power may perhaps be here given. Eight years ago the author visited what was then, and is probably now, some disused machinery at St. Germains in Norfolk. The works were constructed for the purpose of draining low-lying land a few miles from King's Lynn, which is, as you know, at the mouth of the River Ouse. A channel was cut from the Ouse for a distance of eleven miles south of King's Lynn, and at four miles from the town a huge dam was thrown across the channel for the purpose of preventing the tide from flooding the low-lying country on its south side. At low tide it became necessary to liberate the accumulated water on the south side. To this end a series of sixteen siphons, 3 feet in diameter, were conveyed over the dam, and protected from the damaging effects of drifting ice and timber by a large screen. To start the siphons it was necessary to exhaust the air within, and to accomplish this the vertical bodies of the siphons were connected by means of a tube attached to an exhaust pump driven by a stationary engine. The air within being sufficiently rarefied the siphons commenced to act, and the pent-up water was conveyed over the dam. Taking the head of water to be discharged at 12 feet, there was here a large available horse-power unutilised for the whole of the time during which the seven miles of channel were being emptied.

II. Water Motors.

To utilise the power existing in water in its natural channels, and under ordinary atmospheric conditions, as opposed to that from high-pressure water-mains, many motors have been invented, and numerous modifications of these motors made. Water-wheels, turbines, hydraulic rams, and water-pressure engines are the principal motors at present in use; these again being subdivided into innumerable types. The author has not the experience necessary to go very deeply into a comparison of the merits of the various types of motors, but he hopes that Members present who have erected satisfactory machines will give particulars of such.

Molesworth gives the following theoretical horse-power of water:—

Q = Quantity of water in cubic feet per minute.
h = Head of water from tail-race in feet.
H.P. = Theoretical horse-power.

$$\text{H.P.} = \cdot 001892\, Q\, h.$$

$$Q = \frac{528\cdot 5\ \text{H.P.}}{h}$$

And the following effective horse-power for different motors:—

Theoretical power being	1·00
Undershot water-wheel	·35
Poncelet's undershot water-wheel	·60
Breast-wheel	·55
High breast-wheel	·60
Overshot wheel	·68
Turbine	·70
Hydraulic ram raising water	·60
Water-pressure engine	·80

Energy is due to three conditions of a head; corresponding to each of these three forms which the head takes there is a class of water-motors. By a bucket water-wheel we can recover the energy corresponding to an unexpended part of the fall; by a pressure engine we can get the energy due to the pressure, and by a turbine we can get the energy due to the velocity.

WATER-WHEEL.

This simple yet powerful motor was probably about the first machine invented by man for labour-saving purposes. Water-wheels are divided into two main classes—undershot wheels and overshot wheels. In addition there are the breast water-wheels which are a combination of the two.

Undershot Wheel.—In this wheel motion is generated by exposing obstacles to the action of a water current. The wheel is merely furnished with a series of plane surfaces or floats projecting from its circumference, for the purpose of receiving the impulse of the water delivered under the wheel. The power is communicated from the spindle upon which the wheel revolves. As it acts chiefly by the momentum of the water, the weight of the water being scarcely called into action, it is only proper to be used where there is a great supply of water always in motion. It is the cheapest of all water-wheels, and is more applicable to rivers in their natural state than any other form of the wheel; it is also useful in tide currents, where the water sets in opposite directions at different times, because it receives the impulse equally well on either side of its floats. The effective horse-power of undershot water-wheels

$$= \cdot 00066\, Q h.$$

Quantity of water in cubic feet per minute

$$= \frac{1511 \text{ H.P.}}{h}.$$

The Persian wheel, which is a modification of this wheel, is a simple apparatus for raising water. A number of buckets, movable about an axis above their centre of gravity, are suspended to the rim. As the wheel goes round, the buckets enter the water in succession and are carried up full. When they reach the height of the diameter of the wheel, they strike against a fixed obstacle, so as to tilt over and empty their contents into a spout or reservoir placed to receive them. It is generally used in connection with a system of irrigation.

Poncelet's undershot water-wheel is a much more serviceable machine than the common type, the flat floats in the latter being replaced with curved floats, which take up the impulse of the water to a greater extent, and also present a greater surface to the current. The effective horse-power of this machine

$$= \cdot 00113 \, Q \, h.$$

Quantity of water in cubic feet per minute

$$= \frac{880 \text{ H.P.}}{h}.$$

Overshot Wheel.—The circumference of this wheel is provided with buckets or receptacles, the water is delivered from above, and is retained during a part of the descent. The buckets on one side being erect, will be loaded with water and the wheel will be thus set in motion; the mouths of the loaded buckets being thus turned downwards by the revolution of the wheel, will be emptied, while the empty buckets are successively brought under the stream by the same motion and filled. In this wheel the weight as well as the momentum of the water is used, and a much greater power is therefore produced with a less supply of water than is necessary for the undershot wheel. The effective horse-power of overshot water-wheels

$$= \cdot 00128 \, Q \, h.$$

Quantity of water in cubic feet per minute

$$= \frac{777 \text{ H.P.}}{h}.$$

Breast Water-wheel.—This wheel differs from the overshot in receiving the water about the level of the axle. It is sometimes classed under two heads—high-breast and low-breast. The effective horse-power of the high-breast

$$= \cdot 00113 \, Q \, h.$$

Quantity of water in cubic feet per minute

$$= \frac{881 \text{ H.P.}}{h}.$$

Effective horse-power of the low-breast

$$= \cdot 00104 \, Q \, h.$$

Quantity of water in cubic feet per minute

$$= \frac{961 \text{ H.P.}}{h}.$$

In order to permit all these wheels to work with freedom and to the greatest advantage, it is necessary that the back or tail water should have an uninterrupted passage off, for otherwise it accumulates and forms a resistance to the float-boards.

Turbine.

The name is derived from the Latin *turbo*, a whipping-top, from the similarity of the motion. The turbine is a development of the water-wheel, and comprises any wheel driven by water escaping through small orifices, the revolution of which is due to the pressure derived from falling water. The horizontal turbines are much the commonest. Barker's centrifugal mill was the first type constructed, acting not by the weight or momentum of the water, but by the reaction caused by the water spouting out of horizontal tubes having apertures in opposite directions. Improved turbines based upon the principle of Barker's mill have from time to time been invented. The first chief improvement was by Fourneyron, who, in 1827, constructed a machine by which the force of the water is more completely utilised. In this machine the water is supplied by a vertical pipe, but, instead of at once escaping through radial arms, it first passes over a fixed plate through a number of channels curved in such a manner as to give the water on leaving these channels a direction tangential to the circumference of the plate. From these channels the water passes into similar channels in the revolving wheel curved in the opposite direction, and finally escapes at the circumference of the wheel. Turbines such as Fourneyron's, in which the water is supplied at the centre and flows outwards, are called outward-flow turbines; and those in which the water is supplied at the circumference and escapes by an orifice at the centre are called inward-flow turbines.

Turbines are much smaller than ordinary water-wheels, but revolve much more rapidly. They can be placed in almost any situation, water being led to and from them in pipes. They occupy far less space than water-wheels and are easily fixed. They will work in any depth of water, giving the proportionate power that is available between the head and tail water. They give a higher percentage of power with a given quantity of water than is obtainable with other water-wheels. Gear for increasing the driven speeds with ordinary water-wheels is dispensed with. The first cost of turbines, except those for very low falls, is less than for ordinary water-wheels made in iron, of corresponding power. Where the fall of water is small they yield a better, but where it is great a worse, result than the other wheels. Where, however, the fall is more than 40 feet, ordinary water-wheels cannot as a rule be conveniently used, while turbines can be used for falls of several hundred feet. Turbines are therefore best adapted for small and very great falls, and the ordinary water-wheels for moderate falls of water.

Jonval's low-pressure turbines are suitable for falls of 30 feet and under. They are either fixed in pentroughs, or inside a close case, according as the fall is great or small.

The effective horse-power of turbines

$$= \cdot 079\,Q\,h.$$

Quantity of water in cube feet per second

$$= 12 \cdot 67\,\frac{\text{H.P.}}{h}.$$

The volume of many streams could be increased by leading smaller streams into the one channel, should an increased power beyond that existing be necessary. Under many conditions the water, after leaving the turbines and other motors, would flow on without in the least interfering with the existing rights of mill-owners and others.

Hydraulic Ram.

Hydraulic rams are used for the raising of water only, and are actuated by the weight of the water which they have to raise or other source of energy—such as sewage water.

The useful effect is nil when the lift reaches twenty-six times the fall, and no delivery can then be expected.

The lifting capacity of hydraulic rams is very small comparatively, and as they do not provide motive power, municipal engineers can find little use for them. The effective horse-power of the ram

$$= \cdot 00113\,Q\,h.$$

Quantity of water used in cube feet per minute

$$= \frac{881\ \text{H.P.}}{h}.$$

WATER-PRESSURE ENGINE.

Water may be brought to act upon the piston of an engine in precisely the same way as steam acts in a steam engine, the pressure being according to the head of water utilised. There is a considerable loss of energy in the flow of water due to friction, consequently a water-pressure engine must be run at a much less speed than a steam engine, the frictional losses of energy in a fluid being proportional to its weight. A steam engine has a piston speed of 400 or 500 feet per minute; a water-pressure engine rarely has a speed exceeding 80 feet per minute. It is just when an exceptionally high pressure can be obtained, or requires to be used, that the water-pressure engine is most applicable. One of the drawbacks of this type of engine is that the same amount of energy must be expended each stroke whether the load is heavy or light. These engines work with good efficiency when the fall and lift are constant, and when quite proportioned to the work to be done.

The effective horse-power of a water-pressure engine

$$= \cdot 00151\, Q\, h.$$

Quantity of water in cube feet per minute

$$= \frac{661 \text{ H.P.}}{h}.$$

HYDRAULIC MAINS.

Bramah, in 1796, by an ingenious contrivance, first gave the principle of the hydrostatic press a practical application. He saw that the incompressibility of water formed a favourable medium for the transmission of force, and it was utilised by him by means of a small pump at a high pressure, acting with the least possible loss by friction on a large piston or ram, thus obviating the necessity of gearing.

It was not, however, until fifty years after this that water pressure was utilised in other directions for power purposes. In 1846, Lord Armstrong erected the first hydraulic crane at Newcastle Quay, since which date numerous and valuable machines driven by water pressure have been invented. Lord Armstrong, Mr. Ellington, and Prof. H. Robinson were the first to inaugurate the laying of high-pressure water-mains in towns for the purpose of providing power for the use of private consumers, without their having to separately erect the generating plant necessary for causing the required artificial head. The author here begs to acknowledge that much of the information contained in this paper is obtained from the experience of these gentlemen, and also from Prof. Unwin.

Hydraulic mains have been laid in Hull, London, Birmingham, and other towns, side by side with gas and water-pipes. The most economical pressure to use appears to be about 800 lbs. to the square inch, which is generated by steam engines pumping into the mains and accumulators.

The accumulator, which fulfils most important functions in connection with the mains, may be described as a cylinder in which a ram works, the top of which is weighted to the required pressure. This weight, which is raised as the piston ascends, of necessity gives the water an artificial head, equal to a column of water of great height. If, for instance, the pressure within the main is 800 lbs. to the square inch, it is the equivalent of a column 1848 feet high, which for practical purposes in most instances it would be almost impossible to obtain. Besides serving to produce an artificial head, the accumulator also stores up the water pumped when it is in excess of the water consumed; and, in fact, performs in the hydraulic system the functions of the fly-wheel of a steam engine. As the consumption of water by the machines connected with the main falls below the supply of water pumped by the engine, the ram rises and stores in the cylinder the excess, until the ram has risen to the top of its stroke, when it cuts off the steam from the engine by closing the throttle-valve. On the other hand, when the consumption of water by the machines is greater than is being supplied at the time by the engine, the ram falls and supplies the deficiency, at the same time opening the steam throttle-valve by which the full power of the engine is brought into operation. The accumulator thus acts as a reservoir of power and as a conservator of its distribution.

Prof. Unwin writes concerning the power to be obtained from hydraulic mains, "The pressure is too great to be conveniently applied in a turbine, and the pressure engine in its ordinary form is too extravagant in its consumption of water for ordinary power purposes."

Without going into the relative advantages of the various types of pressure engines, we may mention that the "Hastie," the

"Brotherhood," and the "Pelton," are being used in London for power purposes. These machines have an efficiency of from 80 to 85 per cent. The Chester Hydraulic Engineering Company (who constructed the hydraulic machinery used by the London and Hull Hydraulic Power Companies) state that they have recently fixed in London, besides a large number of "Brotherhood" hydraulic engines, several "Pelton" motors. This is a high-speed motor and has a somewhat greater efficiency than the "Brotherhood." For slow driving or for machines which require to be frequently stopped and started, the "Brotherhood" engine is the best; but for high speed machinery, such as for driving dynamos, the "Pelton" is recommended, as there is no necessity for intermediate gearing and the full power of the motor is utilised.

Possibly, as motive power is not a necessity to people, in the same sense as drinking water is, it will be some time before municipalities undertake the installation of power-mains themselves, but that it may some day be the duty of municipal engineers to lay them down is not unlikely.

III. Application of Power.

In many directions there is undoubtedly a field for the utilisation of water-power in conjunction with that of electricity. A great deal of water runs away year after year, unused, to the sea, which might be the motive power for driving electromotors and for producing electric light. Particularly is this the case in small towns and villages, which by the introduction of these facilities might find it possible to carry on many industries with greater advantage than at present. This would be a desideratum not to be despised, as it is now the object of statesmen, if possible, to prevent people from crowding into the larger towns, seeking the employment which to a considerable extent is dependent upon efficient machinery. As a body of men having at heart the physical welfare of the inhabitants of our towns, we should welcome the results foreshadowed here as a most desirable thing.

Some public authorities who are in the unfortunate position of not owning the gas-works, have frequent and reasonable cause for complaint with respect to both the efficiency and the price of the light supplied to the street lamps. Where the conditions of the locality are favourable for the utilisation of water for driving dynamos for producing electric light, the public authority is possessed of a strong lever for the reduction of its gas bill, if it does not inaugurate electric lighting.

A case in point occurred not long ago at Carlow. The municipal authorities quarrelled with the gas company and determined to discontinue gas lighting, and to start electric lighting instead. Carlow being situated at the junction of the rivers Barrow and Burren, plenty of water-power was available. A disused corn-mill, five miles away from the town, was converted into a dynamo-room, the old water-wheel of the mill doing the necessary work. It is, however, intended to erect a turbine in the future. The wires conveying the current are carried overhead on poles to the town.

Efforts are being made in the Alpine countries to use the masses of water which rush wildly down the mountain sides, as a means of producing electricity. Turbines placed at the foot of the falls are turned by the force of the water, and a dynamo is attached to the turbine and driven by belting. In this way no fewer than twelve towns in Switzerland are fixing up electrical apparatus for lighting and power purposes. In places where falling water abounds, electrical energy can be produced cheaply. As an illustration it may be mentioned that an electrical company has been formed at the village of Faide, on the Gothard Railway, a place numbering 1000 inhabitants. By means of an iron pipe, a small supply of water is obtained from the neighbouring Pinmogna torrent, which drives below a small high-pressure turbine, which in turn drives a dynamo supplying 360 glow lamps. The whole cost is under 2000*l.*, which sum is divided into shares of 15*l.*, the owners forming the company. In this manner, in addition to the streets and railway station, the peasants and working men have their houses supplied very cheaply with the electric light, which is elsewhere regarded as a luxury, but which Prof. Preece regards as a great sanitary agent.

When Mr. W. B. Bryan, C.E., was the Borough Engineer of Blackburn, he had to deal with the sewage of a district which had been newly incorporated by an extension of the Borough boundaries, and lying 24 feet below the sewage outfall. He therefore designed a pumping station, the engines to be actuated by pressure from the town mains. The pressure in the mains was 125 lbs. to the square inch. The engines worked automatically, and were capable of raising 1,000,000 gallons in 24 hours 24 feet high.

Mr. Baldwin Latham in a number of cases has been using high-pressure water for transmitting power for automatically pumping sewage. At Friern Barnet, for instance, he is transmitting power from the sewage works to a point a mile distant, and lifting the sewage of an isolated district 55 feet high into the gravitation sewers.

Sewage is raised at Brentwood by means of a water-wheel.

Small motors driven by sewage are used for working lime-mixers, &c.

In connection with power-mains, a small jet of high-pressure water injected into a larger jet from the waterworks mains intensifies the pressure of the latter in the delivery hose, and also increases the quantity.

A pressure of 40 lbs. to the square inch in a water-main will throw the water issuing from a hose to a height of from 40 to 50 feet; but if water is turned on through a $\frac{3}{8}$-inch opening from the high-pressure main of 750 lbs., the water will rise to a height of from 90 to 100 feet through the atmosphere. Sir E. M. Shaw says this result would be very satisfactory, the pressure being as great as from a fire engine.

Another application of water-power was made in the iron subway under the Thames just below Kingston Bridge. The subway was constructed of cast-iron plates bolted together in segments, forming rings 18 inches deep, the diameter being 9 feet. The method employed in driving the tunnel and fixing the plates was similar to that adopted in the construction of the City and South London Electric Railway. An iron shield of slightly larger diameter than the subway itself was forced forwards into the clay by powerful hydraulic jacks for a distance of about 18 inches, sufficient to insert one ring of the cast-iron plates.

The Tower Bridge is provided with two steam pumping engines for hydraulic machinery, each 360 H.P., eight large hydraulic engines, six accumulators, and four hydraulic lifts in towers for passengers.

The hydraulic forging presses at modern engineering works far exceed the Nasmyth hammer, which was once considered to give wonderful results. These presses are of 4000 tons, and are worked by 2000 H.P. pumping engines, and commanded by travelling cranes capable of lifting 150 tons. Altogether, hydraulic power is very serviceable in the working of ponderous machine tools, as it is also in the working of cranes, &c.

We are indebted to water-power in no small degree for the cleanly and noiseless lifts which are the comfort of lofty houses and flats.

No doubt the efficient utilisation of water-power presents many difficulties which it is the duty and privilege of engineers to overcome. Surely there is a splendid field in many directions for the employment of such a well-understood natural power as that of water.

A SKETCH OF THE GEOLOGICAL FEATURES OF ROSSENDALE.

By HERBERT BOLTON, Esq.,

Assistant-Keeper Manchester Museum, Owens College,
Extension Lecturer of the Victoria University,
Author of 'The Geology of Rossendale.'

The district of Rossendale, in Lancashire, is one especially fitted for the study of those sandstones, shales, and thin coals which are denominated by geologists, the Millstone Grit Series and Lower Coal Measures. Commencing at the extreme western limit of the division, the observer can trace an almost uninterrupted succession of deposits, commencing with the lowest members of the Millstone Grit, and ending with the Derplay Hill Flagrock, which lies about 300 feet below the floor of the Arley Mine, the base-line of the Middle Coal Measures.

The Millstone Grit Series.

The Millstone Grit Series of deposits reach their maximum development in Lancashire, where Professor Hull, F.R.S., has demonstrated them to have a total thickness of 5500 feet.

In the Rossendale area the Millstone Grit acquires a thickness of about 1000 feet, and consists of sandstones, shales, with bands of ironstone, and coals, with their associated underclay or seat-rock.

The Lower Coal Measures of Rossendale have a total thickness of about 800 feet, and consist chiefly of thin coals, separated by great thicknesses of shale.

Taking the several beds of the Millstone Grit in regular order, their sequence is as follows:—

The Millstone Grit Series has been divided into four well-marked subdivisions, viz.:—

First Grit, or Rough Rock.
Second Grit, or Haslingden Flag.
Third Grit.
Fourth Grit, or Kinderscout Rock.

The Fourth Grit or Kinderscout Rock.

The Fourth Grit crops in the neighbourhood of Rawtenstall, and has an approximate thickness of 80 feet. It consists of two beds of compact sandstone, and an intervening parting of shale and a 6-inch coal.

The Third Grit.

The Third Grit has an average thickness of 500 feet, and contains durable sandstones and flagstones. The lower beds of grit are at times especially massive and durable. They can be well seen in a tall cliff overhanging the road at Gauxholme near Todmorden.

The Third Grit has intercalated with it a few coal-seams too thin to pay the working, but remarkably persistent, and well known under the title of the Brooks-bottom Series. The base of the Third Grit is furnished by a bed of shale 10 feet in thickness, and overlaid by a ¼-inch seam of coal. These in turn are overlaid by 30 feet of shale and 60 feet of a coarse sandrock irregularly bedded, and rich in casts of Calamite (Fig. 4) and Lepidodendroid plants.

Above the beds already mentioned lie thin shales, coal, and sandrock, the chief bed being a flagrock 20 feet in thickness, worked at Balladen and Ravenshore. Then comes another succession of shales, with their coals, and occasional rocky bands, the whole series terminating in a bed of hard brown shale 100 feet in thickness, which crops on the sides of the Thrutch Gorge, a narrow defile a quarter of a mile in length, containing the high road from Waterfoot to Stacksteads and Bacup.

Second Grit or Haslingden Flags.

Under this head are grouped most of the sandstones so well known and valued for building and street purposes.

The total thickness of the Haslingden flag series is about 350 feet, of which 120 feet are sandstones.

The basement bed is a fine-grained and exceedingly durable sandstone 44 feet in thickness. Numerous quarries are opened into it.

Next in order occurs a bed of shale which at Great Height possesses a thickness of over 30 feet, falling away to two feet at Stacksteads, a few miles further to the north-east.

The true "Haslingden Flag" rock lies upon the shale already spoken of, and Members will have an excellent opportunity of seeing magnificent exposures of this rock on their visit to Messrs. Butterworth and Brooks' quarries.

It is this rock, *par excellence*, which is most worked and is most valuable for paving sets and purposes requiring considerable durability.

It is by no means uncommon for the quarrymen to find on the bedding planes of this rock marvellously delicate impressions of ferns peculiar to the Carboniferous period. Of these the most common are *Alethopteris lonchitica*, *Sphenopteris*, *Neuropteris*, &c. Casts of *Calamites* and *Sigillaria* also occur.

Brown and black shales 150 feet in thickness succeed the chief Haslingden Flag, and are interesting chiefly for the crushed remains of *Goniatites* and *Aviculo-pectens*, which are to be found in them (Figs. 12 and 13).

The highest member of the sandstone group of the series is a hard sandrock 44 feet in thickness. It is exceedingly hard, and is much used. Many quarries are opened into it at Britannia and elsewhere.

The last and uppermost member is a dark shale 30 feet thick. It is occasionally exposed in quarrying operations in the overlying Lower Rough Rock.

The First Grit of Upper Rough Rock.

This consists of two beds of coarse sandstone grit, containing a variable proportion of decomposed felspar as a cementing material, along with hydrated peroxide of iron. The decomposed felspar is in the form of a fine white powdery looking mineral, and where present in great abundance causes the quartz grains to readily fall asunder. In other words, those portions of the rock rich in decomposed felspar, show the effect of weathering very quickly, and are of little value.

The iron causes the stone to take a brown colour and is usually so small in quantity as to fail in destroying the durability of the rock. The best parts of the two beds composing the Rough Rock are of a pale blue colour, the sandstone grains being large and evident and cement material insignificant. The cohesive property of the material and the intimate interlocking of the sand grains seem to be the chief agents in making up a very compact and durable material.

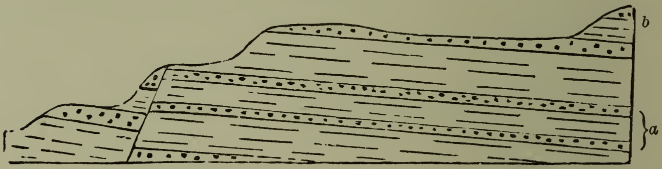
The Lower Rough Rock has a thickness of from 16 to 60 feet, and is overlaid by a fireclay of 5 feet, upon which rests the Feather Edge or Sandrock Mine, 1 foot 2 inches in thickness.

A thin shale crowded with fern remains occurs in some places over the coal, and is in turn succeeded by the Upper Rough Rock. The Upper Rough Rock has a thickness of 15 feet and is a very coarse grit. It is worked but is much inferior in value to the rest.

The First Grit has played a very important part in determining the physical features of Rossendale, and is found as a stony cap to many of the hills. This is the case of Brandwood Moor and Cribden.

In the latter (Fig. 1), which will be well seen from the quarries, lying a little west of north, the presence of the First Grit and Haslingden Flags has given rise to a well-marked steplike appearance. This result has been brought about by the upthrowing of the beds along the northern half of Cribden, and the stripping off of the intervening shales.

FIG. 1.



Diagrammatic section through Cribden.
a = Haslingden Flags.
b = Rough Rock

There are four steps in all, the first being formed of Haslingden Flag, and the second of Rough Rock, the two being repeated to form the third and fourth steps. The softer shales have been destroyed by weathering agencies, and are represented now by the steep slopes leading from one step to another.

The step-like character of the hill-side is a well-marked feature of all millstone grit districts.

THE LOWER COAL MEASURES.

The Lower Coal Measures of Rossendale contain only one coal seam of importance, although several are worked. This, the Gannister Mine, is a seam varying from 2½ feet in thickness to 5 feet. It is a fairly good house coal, and is largely worked. One especial feature of the Gannister Seam is that it "crops" or runs out to the surface, and is in nearly every case mined by driving a horizontal head or tunnel into it from the outcrop, known as a "day eye," and not by means of a shaft.

The next two seams in point of importance are the "Upper Foot" or "Bullion Mine," and the "Upper Mountain Mine."

The Upper Foot is remarkable in that it is separated from the Gannister Seam over the greater part of the district by 40 feet of rock, but in the extreme north-east the latter gradually rises and unites with the Upper Foot, the intercalated rock dying out. At the junction of the two seams, the united thickness runs up to 6 feet. The seam formed by the union is called the "Union" or Five Feet Mine.

The Upper Mountain Mine has a thickness of 1½ to 2 feet. It has been largely worked in time past but is now almost exhausted. It is characterised by containing masses of iron pyrites or sulphide of iron, called "brass" lumps by the miners.

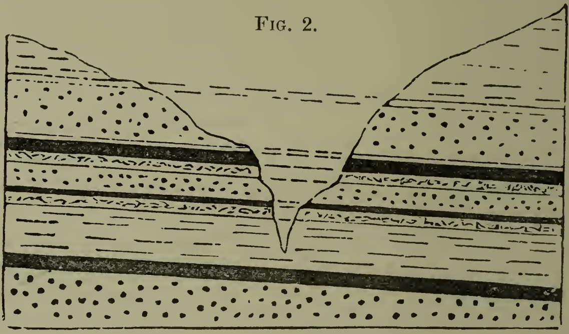
The chief grits associated with the Lower Coal Measures are the Woodhead Hill Rock, from 24 feet and upwards in thickness; the Tooter Hill Flagrock or "Tumbling Cob," 30 to 60 feet in thickness; the Clough Head Rock, 30 feet thick; the Heald Flagrock or Old Lawrence, 30 feet thick; and the Derplay Hill Flagrock, 10 feet and upwards in thickness. Of these the most important from a commercial point of view are the Woodhead Hill and Clough Head Rocks.

The former is a fine-grained sandstone, strongly coloured with iron, but forming in many places a good building stone. The Clough Head Rock is an exceedingly good and compact fine-grained sandstone of a pale yellow colour. It forms a thoroughly good building stone. The basement portion is especially massive.

The remaining beds are of much less importance, the Tooter Hill Flagrock is coarse and soft and readily crumbles. The Heald Flagrock is made up of two beds separated by a 2-foot parting of shale. Formerly this rock was much in request as a roofing slate for houses, but it has become wholly displaced by Welsh slates.

The Derplay Hill Flagrock has been worked on the summit of Derplay Hill from which it takes its name. It is a fine-grained flagrock. The Members in driving from Bacup round by Derplay to Clough Bottom will have good opportunities of seeing the exposures of the coal seams mentioned, Fig. 2, and also old quarries in the various grits. Under the lee of the Derplay Hill quarries occurs the source of the Irwell, the main tributary of the Mersey. It commences as a spring in the vicinity of the dislocation known as the Derplay Hill Fault.

FIG. 2.



Section of Broadclough Valley, showing outcrop of coal seams.

Passing from Bacup to Derplay the Members will see the broken ground of the Derplay Hill Fault, and exposures of the Gannister Mine, the shales, and the Woodhead Hill Rock.

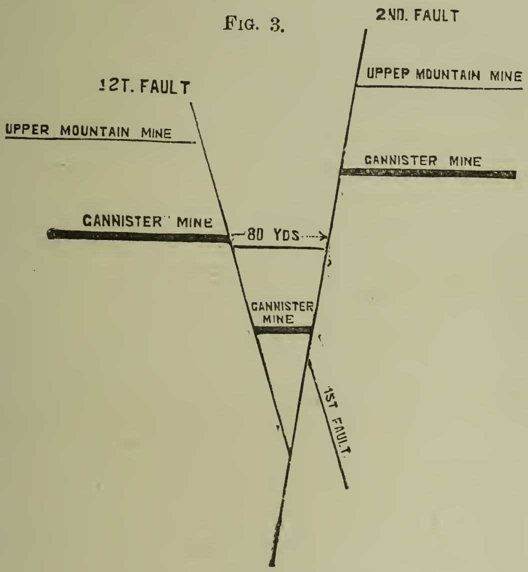
Should the day prove clear and fine, the Members will have an excellent opportunity of seeing from the summit of Derplay Hill a wide vista ranging over the Lancashire plain and including such heights as Pendle Hill, the flanks of the Pennine Chain, and Blackstone Edge. The general configuration of a Millstone Grit country will also be very evident.

The scenery is also of a pleasing character, some of the "cloughs" which will be passed being scarcely inferior to the glens of the Isle of Man.

FAULTS.

The district is traversed by a series of dislocations, or faults, one of which the Members will have an opportunity of viewing, viz. the Derplay Hill Fault. The most interesting fault of the district is that known as the Gambleside Fault. For some time it was regarded as a single line of dislocation, but on being proved it was found to be double, the two *hades* inclining towards one another. The first dislocation resulted in the Upper Mountain Mine being brought down to the level of the Gannister Seam, so that the miners in following up the latter worked straight across the broken ground into the Upper Mountain Mine. The second dislocation threw the Gannister Seam above its former level.

Fig. 3.



Section of Gambleside Fault.

Characteristic Fossils.

Tree-like Plants.—The fossil remains of plants occur sparingly in the sandstones in the form usually of casts, covered by a thin film of coaly matter. In the dark carbonaceous shales associated with the coal seams, the plant remains are exceedingly abundant, and often show the external features of the stems and leaves in great perfection.

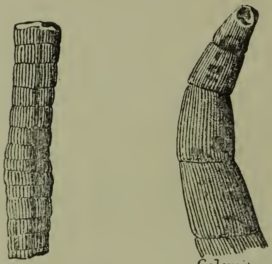
In some cases, as for instance in the Bullion Mine, earthy nodules are found, in which fragments of twigs, stems, &c., are so admirably preserved that the minutest details of structure can be made out.

The commonest fossil plants are the following:—

Sternbergia.—Found in the form of gradually tapering stony rods marked by a series of concentric ridges. They are generally held to be casts of the pith cavity of plants called Lepidodendra, allied to the living club-mosses, but, unlike the latter, they grew to the dimensions of trees.

Calamites.—These fossils, which are very common, occur in the form of flattened, jointed cylinders, marked by longitudinal flutings. They are external or internal casts of plants allied to the living Horsetails, or Equisetæ.

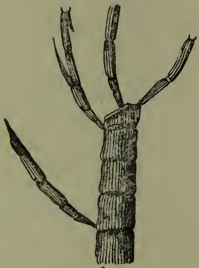
FIG. 4.



Calamites *approximatus*

Calamites *cannæformis*

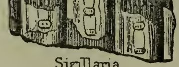
FIG. 5.



Calamites.

Lepidodendron.—A term applied to impressions of the rhomboidal leaf-scars of tree-like plants allied to the club-mosses. These fossils are amongst the prettiest of the Coal Measure flora. They are common in the coals, and the overlying shales, but rare in the sandstones.

FIG. 6.

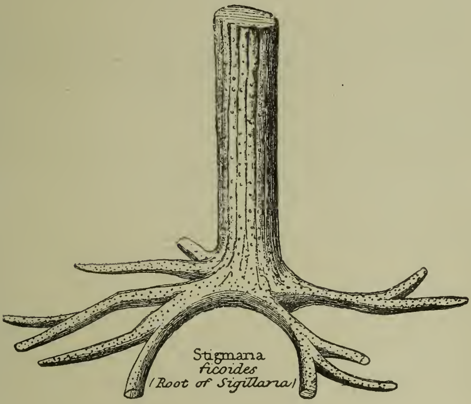


Sigillaria *reniformis*

Sigillaria.—These fossils, which occur in great profusion in the coal, have at first sight a close resemblance to the forms known as Calamites, but they differ from the latter in the absence of joints and in the longitudinal flutings of the stem being broad, and marked along their whole length by leaf-scars.

Stigmaria.—The commonest of all coal measure fossils, is the structure known as Stigmaria. It occurs in the shales, sandstones, and most of all in the underclay, or seat-rock which underlies all the coal seams. Stigmaria has the form of a stout stem-like structure, usually oval or elliptical in cross-section, and marked on the exterior by a series of deep pits arranged in spiral fashion. It is now regarded by the chief authorities as a creeping stem or rhizome, of plants of the Sigillaria and Lepidodendroid type.

Fig. 7.

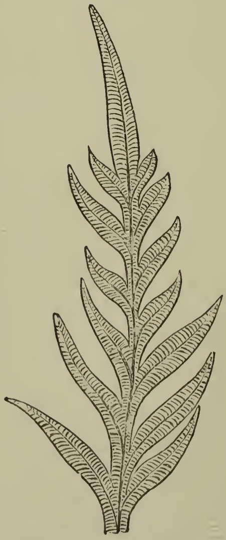


Ferns.—The shales and coals of the Lower Coal Measures yield a profusion of ferns, many of which still possess a beauty of form and delicacy of structure difficult to match amongst existing ferns. Not unfrequently, great patches of shale forming the roof of a mine show a mass of crushed and tangled ferns, the outlines of each being still perfectly clear and sharp, and standing out in glossy blackness against the background of dull shale. The ferns of most common occurrence are the following:—

Alethopteris.—A tall branching fern, usually found in a fragmentary condition. It consists of a stout stem, giving off on either side a series of narrow pointed leaflets or pinnules, each of which is marked by a great number of fine raised veins, which run from the central line or midrib to the edge.

Pecopteris.—A much stouter fern than the preceding, and much more branched. In this form, the leaflets or pinnules are

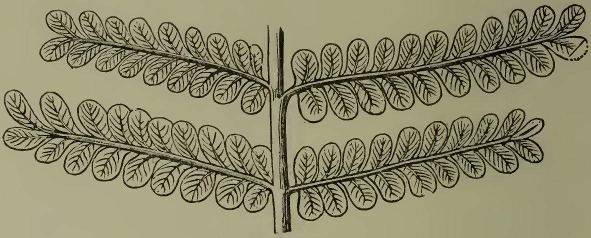
Fig. 8.



Alethopteris lonchitica.

short and broad, blunt at the apex, and marked with few veins which run obliquely to the edge.

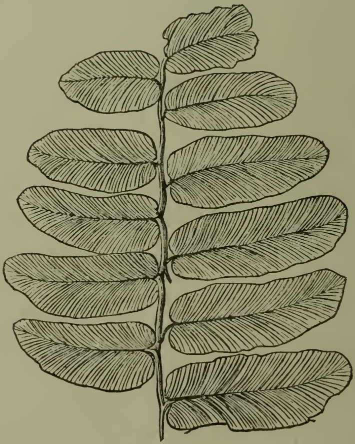
FIG. 9.



Pecopteris.

Neuropteris.—A form in which the leaflets or pinnules are very broad, blunt at the apex, and attached to the main axis by a short stalk. The surface of each pinnule is covered by a series of fine veins which run out obliquely from a central midrib to the margin.

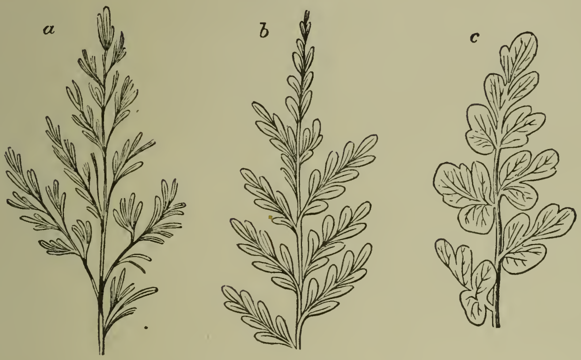
FIG. 10.



Neuropteris.

Sphenopteris.—A very pretty fern. It is characterised by the stem branching considerably, and bearing a great number of delicate pinnules, usually broadest at the apex, and narrowing to the base.

FIG. 11.



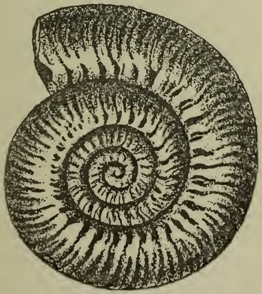
a, Sphenopteris affinis. *b*, S. obovatum. *c*, S. latifolia.

FISHES.—The shales lying under the Upper Mountain Mine yield the scales and teeth of fishes. The scales consist of a hard outer coat of enamel or ganoin, resting upon a bony base. The teeth are long, acutely pointed, and occasionally fluted at their base.

The character of the scales caused the fishes of this period to be practically armour-clad, whilst the teeth show them to have been predatory and voracious.

Goniatites.—The Cuttle-fishes of to-day were represented at this period by a series of forms called Goniatites. In these the body

FIG. 12.



Goniatites listeri.

was invested by a shell coiled upon itself in one plane, and built up of a series of chambers communicating with one another by means of a tube called a syphon.

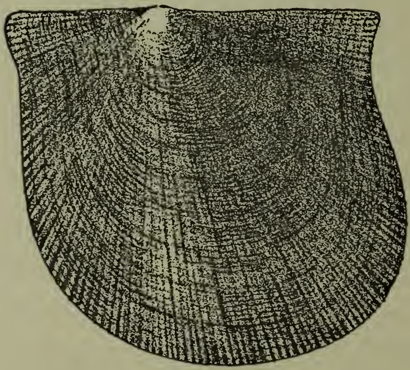
Orthoceras.—Closely allied to Goniatites was a form known as Orthoceras. It differed from the former in that the shell was perfectly straight.

Bivalve shells are represented by two very common forms, Anthracosia and Aviculo-pecten.

Anthracosia.—A shell much resembling the common mussel, and usually occurring in great quantities, if at all. Bands of Anthracosia are often very persistent in the shales, and are very useful as guides in tracing the succession of deposits.

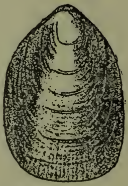
Aviculo-pecten.—An unequal-valved shell, somewhat similar to a living pecten in appearance, but marked by a great series of fine ribs which radiate from the hinge-line to the margin. On account of the thinness of the valves, they are mostly found in a flattened condition.

FIG. 13.



Aviculo-pecten papyracerus.

FIG. 14.



Lingula squamiformis.

Lingula.—Small flattened shells, longer than wide, and marked by faint concentric lines of growth. Common in the shales of the Millstone Grit Series.

BURY CORPORATION WATERWORKS: DESCRIPTION OF CLOUGH BOTTOM RESERVOIR.

By J. CARTWRIGHT, M. Inst. C.E.

The Bill authorising the construction of this reservoir was passed in August 1889, and the works were commenced in May 1891.

The top bank is at an elevation of 1015 feet above Ordnance datum, the top water line being 1010 feet above Ordnance datum. The natural drainage area is 421 acres and is augmented by an area of 315 acres brought in by a catch-water drain about a mile in length. The mean annual rainfall is 35 inches, and deducting 14 inches for evaporation leaves an available fall of 21 inches for the purposes of the reservoir. The compensation water amounts to 540,000 gallons per day of 12 hours. The area of the top water is 32 acres and the capacity of the reservoir is 202,000,000 gallons, allowing an available supply for 30,000 consumers, 25 gallons per day for 175 days. The main embankment contains some 217,000 cubic yards, has a maximum height of 76 feet, a maximum width of 490 feet, with an area of 6¼ acres, and is 20 feet wide at the top. The internal slope is covered with pitching, varying in thickness from 12 inches at the top to 9 inches at a vertical depth of 35 feet below, laid on shingling. The external slope from top bank to the first benching is 2 to 1, from the first to the second benching 2½ to 1, and from the second benching to the toe of the bank is 3 to 1, and is drained throughout with earthenware pipes. The puddle wall is 7 feet wide at the top and batters outwards 1 in 12 on each side till reaching the natural surface of the ground, where it is sloped inwards at 1 to 1 until reaching a maximum width of 12 feet, at which width the trench is carried down. Where the puddle is less than 12 feet in width reaching the natural surface of the ground the trench is carried at such less width. The puddle wall is backed on each side by fine material 20 feet wide at its top and battering outwards 1 in 4. The total length on top bank is 1165 feet, and a road 12 feet wide and a footpath 3 feet wide are carried across and over the bye-wash, by a bridge 12 feet wide and 20 feet span, and connected to the diverted highway. A storm wall 4 feet 6 inches in height and curved to meet the pitching is carried across the bank.

Tunnel and Shaft.

The water from the reservoir is conveyed through the embankment by means of a tunnel 496 feet in length, driven for almost the entire length in the solid. Its internal diameter is 5 feet 6 inches and is built of three rings of brickwork, the undermost being blue brick surrounded by 12 inches of lime concrete from the inlet bay to the shaft, and from the shaft to the outlet bay by 12 inches of cement concrete. It is curved at each end to a radius of 90 feet and goes in a straight line through the puddle trench where it is supported on a concrete block carried down to the bottom of the trench. Where the inlet tunnel joins the shaft the diameter is increased to allow of the construction of the stop-piece, which is built of brickwork in cement 6 feet thick, and through which two cast-iron pipes are carried, one 30 inches diameter for the relief of the reservoir and one 16 inches diameter for supply, the latter being carried to the mouth of the outlet tunnel before being driven through its side and into the solid. The compensation water can be delivered from either of the pipes as occasion may require. The valve shaft is built entirely in cement and is 11 feet square for a height of 14 feet from the bottom, and is there corbelled in to a diameter of 8 feet, at which it is carried up to the level of top bank a further height of 57 feet.

With the exception of the radial work in the tunnels, the whole of the shaft is constructed of masonry and concrete, and built into the walls of the shaft are two draw-off pipes, one at 20, and the other 40 feet below top water, together with the girders necessary for the support of the valves. The valves are in duplicate for each draw-off, the outer valve in each case being worked by capstans from the top of the shaft, and the inner ones kept in reserve. The valve shaft will be approached from the bank by a lattice-girder steel foot-bridge of 50 feet span, resting on a masonry pier on the bank.

Bye-channel.

For the purpose of controlling the flood waters, the bye-channel diverts the two chief streams past the reservoir, and the total length of bye-channel is 950 yards, varying in size according to the area drained, the bye-channel section being 10 feet wide and 5 feet in depth, with side walls before reaching the point where it passes under the catch-water; it is afterwards joined by the catch-water bye-pass channel, and there joins in the bye-wash.

Weir and Bye-wash.

The crest of the weir is 45 feet in length, with side walls 5 feet high, and from the overflow to the centre of puddle trench the bye-wash is 21 feet wide, paved with 15-inch squared pitching set on 12 inches of cement concrete. The bye-wash is narrowed from 21 feet at the puddle trench to 15 feet in width, with side walls 4 feet high and paved with 12-inch pitching, set on a bed of 12 inches of lime concrete, which form of channel is carried down to the gauge basin which is placed immediately below the junction of the tunnel outlet channel and the bye-wash; the total length of the bye-wash is 800 feet.

Catch-water.

The catch-water, which is 1763 yards in length, is of various widths and depths, and with side slopes of 1 to 1, paved with 9-inch squared pitching, set on 6 inches of lime concrete. There are seven streams taken into the catch-water, an intake being provided for each with a pyramidal filter of rubber for the stoppage of wreckage brought down by floods and made water-tight from sewage.

The catch-water is carried under the road diversions by a bridge 14 feet span and 36 feet wide, and over the bye-channel by another bridge 9 feet 6 inches span and 7 feet wide, and from there into the reservoir. Two shutters are placed, one in the catch-water and one in the bye-pass channel near to the crossing of the catch-water over the bye-channel, for the controlling of the flood waters of the catch-water.

Road Diversion.

The position of the weir, bye-wash, &c., necessitates the diversion of the highway leading from Newchurch to Burnley for a length of 467 yards, a portion of which is in a cutting 25 feet deep.

Boundary Walls.

The property of the Corporation will be enclosed by a rubble wall 6 feet in height, 7600 yards in length.

Pipe Line.

The pipe line from the reservoir to Rawtenstall, the point of junction with the existing mains of the Corporation, will be in length 8980 yards of pipes varying in internal diameter to 14¼, having a total weight of 1600 tons. The pipes will be the ordinary socket and spigot pipes and the air valves of the three ball type, hydrants, &c., &c. The pipes cross a number of bridges which span the streams.

The first contract has been let to Mr. Enoch Tempest, of Matlock Bridge, and includes the construction of the main embankment, inlet and outlet tunnels and channels, valve-shaft, road diversions, catch-water and bye-pass, bye-channel and bye-wash, but includes no ironwork.

On Thursday, the 21st July, the members were entertained at luncheon by the Mayor and Corporation of Bury, at the Derby Hotel. The Mayor, Councillor Ashworth, presided. After the discussion on Mr. Cox's paper, the meeting adjourned to allow the members to visit various public works in Bury. The party was first conducted to Fleet Street and Market Street, to see examples of wood pavement in course of construction; after which brakes (which had been kindly provided by the Corporation of Bury) were entered, and the party drove to the Irwell Forge, which was thrown open to inspection by the kind permission of Messrs. Webb. Here the members were met by Messrs. Webb and their managers, who showed them over the works, and explained the process of manufacture of the heavy rollers which are a speciality of the firm.

The easy manipulation of the rollers, and the heavy forge work, were watched with much interest.

From the Irwell Forge, the party drove to Lowercroft Bleach Works, where similar privileges were enjoyed through the kindness of Mr. H. Whitehead, the proprietor. The various interesting processes which manufactured cotton goods undergo in the subsequent bleaching were here witnessed in their most perfected form. The round of visits was concluded with an inspection of the Whitehead Recreation Ground, which has been laid out by the President, and the important siding, involving a considerable extent of tunnelling, which is being carried out to connect the Corporation Gas Works with the main line of the Lancashire and Yorkshire Railway Company.

In the evening the Annual Dinner of the Association was held in the Town Hall.

On Friday, the 22nd July, the members were entertained to luncheon in the Town Hall, by the Corporation of Bury, Alderman Brierley, Deputy Mayor, presided.

The members then proceeded to pay visits to other manufactories of interest in the district. The party, which was conveyed in brakes supplied by the Corporation of Bury, first stopped at the Peel Mills. These extensive cotton mills were founded by the first Sir Robert Peel, whose name they bear, and whose son—the distinguished statesman—was born near to the mills. A special feature in connection with this mill is the supply of power by Messrs. Musgraves' quadruple engine working at 200 lbs. pressure. The various processes of cotton manufacture were exhibited and explained by the managers of the different departments of the mill. From Peel Mill the members proceeded to the felt hat manufactory of Messrs. Lucas, where they were shown the many processes of shaping, hardening, dyeing, trimming, &c., which the felt passes through before its evolution into a hat. The next visit was to Messrs. Wrigley's paper mills at Bridge Hall. Here the members were shown the different modes of manufacturing paper from rags, esparto grass, and wood pulp. The various departments included the sorting, dusting, and boiling of the materials used; and subsequent making, cutting, and glazing of the paper. Visits were also made by some of the members to the engineering works of Messrs. Mather and Platt at Salford, and of Messrs. Musgrave at Bolton.

In the evening, the members attended, by invitation, a garden *party given in the Manchester Road Recreation Ground by Ald. and Mrs. Parks. During the evening the band of the 1st Lancashire Volunteer Fusiliers played selections of music, and refreshments were served on the lawn.*

On Saturday, the 23rd July, the members took train to Bacup, where they found brakes awaiting them for a drive through the Rossendale Valley to the stone quarries of Sir Thomas Brooks, Bart., and the Clough Bottom Reservoir, which was in course of construction for the Corporation of Bury from the designs of the President of the Association. The first stoppage was made at the extensive millstone grit quarries of Sir Thomas Brooks, at Britannia, where the party was received by the manager and engineer of the works. The great feature of the works at Britannia is that the greater portion of the stone is mined, the shafts being of considerable depth. The production of the quarries includes setts, flags, kerbs, &c. The manager of the quarries having given the members a very hearty welcome, Mr. Herbert Bolton, Assistant Keeper Manchester Museum, Owens College, &c., read his paper on "The Geological Features of Rossendale." (See *ante.*)

The members then drove to Clough Bottom Reservoir, where, after being photographed, they were entertained to luncheon at White Lee House, Clough Bottom, under the presidency of Councillor Bentley, Chairman of the Waterworks Committee.

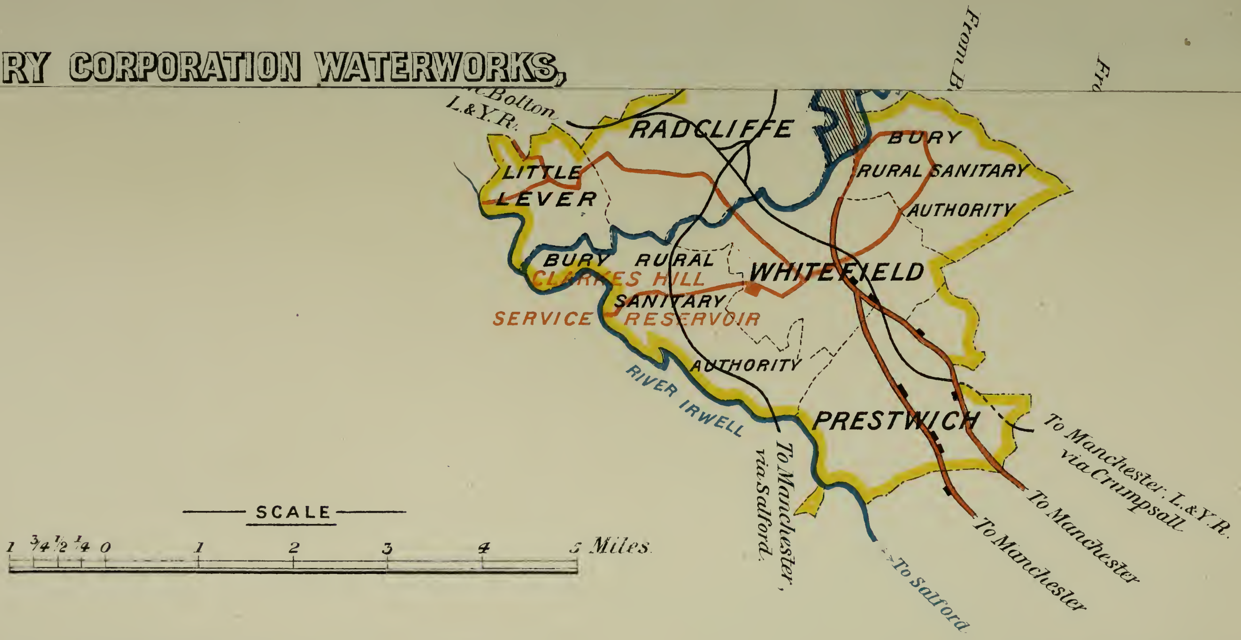
The members then went over the works in progress at Clough Bottom, after which a return was made to Bury.

VOTES OF THANKS.

Votes of thanks were unanimously accorded to:—

- The Earl of Derby, K.G., for the use of the Town Hall.
- The proprietors of the various works visited.
- The Mayor and Corporation of Bury, for their hospitality and generous reception.
- The Ex-Mayor, Mr. Alderman Parks, for his reception at the garden party, and
- The members of the Town Council of Bury who extended private hospitality to members of the Association.

BURY CORPORATION WATERWORKS,

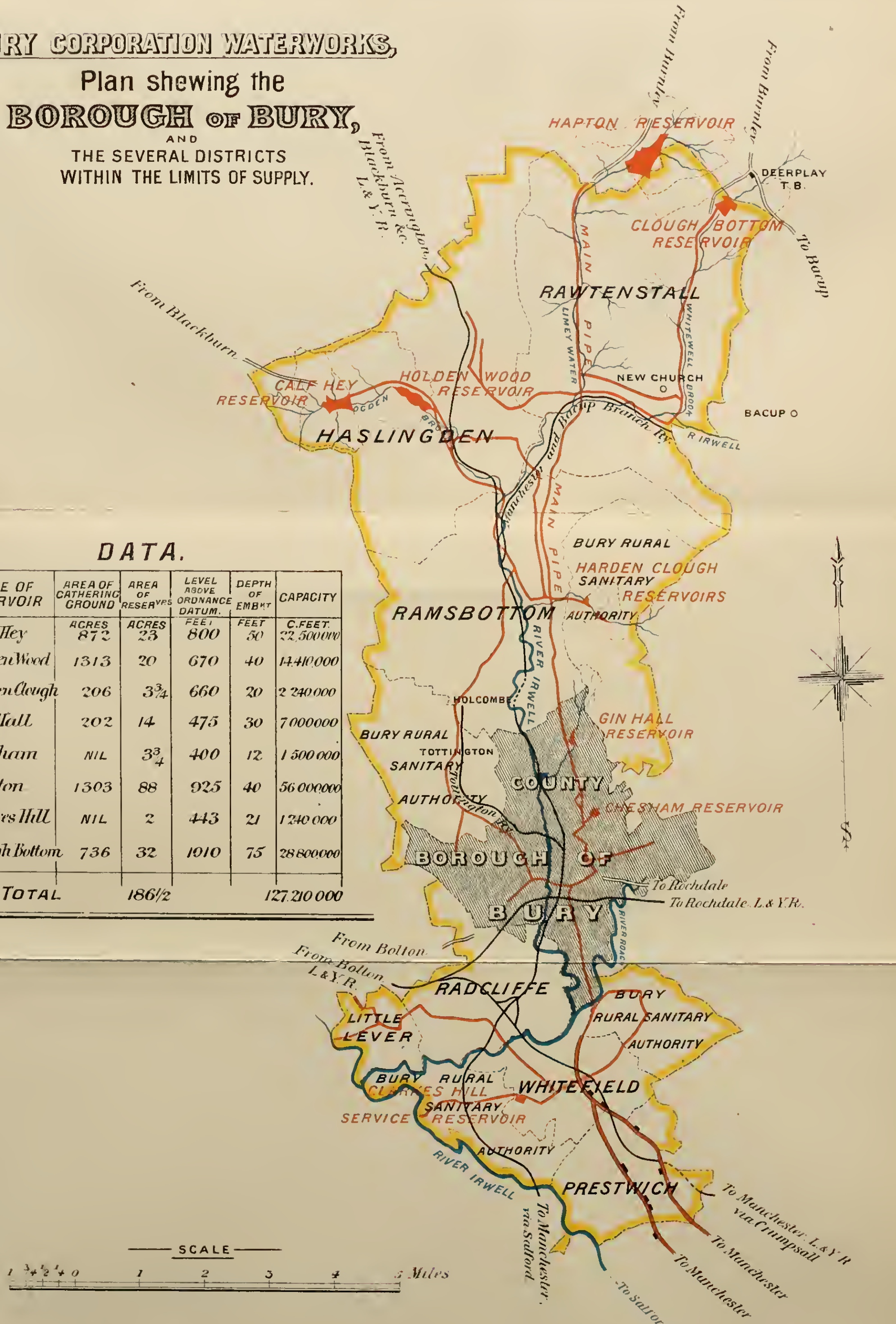


Chas. Fox, Lith., 14 Brown St., Manchester.

J. Cartwright, M. Inst. C.E.
July, 1892.

BURY CORPORATION WATERWORKS,

Plan shewing the
BOROUGH OF BURY,
AND
THE SEVERAL DISTRICTS
WITHIN THE LIMITS OF SUPPLY.



DATA.

NAME OF RESERVOIR	AREA OF CATHERING GROUND	AREA OF RESERVRS	LEVEL ABOVE ORDNANCE DATUM.	DEPTH OF EMBKT	CAPACITY
	ACRES	ACRES	FEET	FEET	C.FEET.
Calf Hey	872	23	800	50	22,500000
Holden Wood	1313	20	670	40	14.410,000
Harden Clough	206	3¾	660	20	2 240 000
Gin Hall	202	14	475	30	7 000000
Chesham	NIL	3¾	400	12	1 500 000
Hapton	1303	88	925	40	56 000,000
Clarkes Hill	NIL	2	443	21	1 240 000
Clough Bottom	736	32	1910	75	28 800,000
TOTAL		186½			127.210 000

Chas Fox, Lith., 14 Brown St., Manchester.

J Cartwright, M Inst C.E.
July, 1892

APPENDIX.

Scientific Notes. A New System of Building and Pipe Construction 418

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A NEW (MONIER) SYSTEM OF BUILDING AND PIPE CONSTRUCTION.

By LEWIS ANGELL, M. Inst. C.E., F.R.I.B.A. (*Past President*).

The author took advantage of the Easter holidays (1892) to visit Berlin, his chief object being to inspect the most successful example of sewage farming in the world, some 20,000 acres in extent. The courtesy and assistance extended to the author by the municipal officials rendered the visit one of great interest and instruction. A very good account of these farms will be found in the paper read by Mr. Roechling before the Institution of Civil Engineers in March 1892. While in Berlin the author had an accidental introduction to Herr Wayss, an engineer-architect of repute, who is directing and developing a new system of construction of very general application to buildings, domes, floors, bridges, reservoirs, tunnels, also to water-pipes and sewers, in substitution for iron, stoneware, concrete, and brickwork. The recommendations of the system are its fire and water-proof qualities, great strength, economy of space, lightness, cheapness, and expedition. The construction is also largely independent of skilled labour. The author, who had not before even heard of the system, had the advantage of inspecting works in actual progress in Berlin, in forms of construction which have already made great way in Germany, Austria, Hungary, and other parts of the Continent, but not yet practically applied in this country. The author was so impressed with what he saw that immediately on his return, in his capacity of Chairman of the Standing Committee on Science of the Royal Institute of British Architects, he felt it his duty to direct the attention of the Institute thereto, and now submits to this Association a somewhat more extended notice thereof.

This system, known as the "Monier and Zisseler construction," consists of a combination of cement, or fine concrete, encasing a network of wrought-iron wire, forming a core, the combination giving very great strength.

It has been proved by tests and experience that the expansion and contraction of the cement and iron are equal, that cement and iron possess great affinities and become a solid mass, and that the iron is not oxidised or otherwise affected independently of the cement. This form of construction gives a maximum of strength with a minimum of material. It has also been proved by tests of the Hungarian Government that arches constructed on the Monier system will bear five times more weight than a corresponding concrete arch, and that Monier slabs or landings will bear twelve times more weight than corresponding slabs of concrete.

The accompanying sketches * will generally illustrate the system which, as above stated, can be applied to various forms of construction.

FIG. 1.

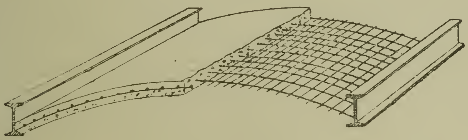
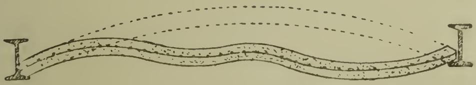


Fig. 1 is an illustration of a fire-proof floor or arch, about 10 feet span and 1¾ inch thick. Upon an ordinary centre of planks a layer of cement and sand, in the proportions of 1 to 3, is laid one-half the intended thickness of the arch. Upon this are laid, wrought-iron wires about ¼ inch diameter, longitudinally and transversely, so as to form a network with about 3-inch interspaces or mesh, the intersections being secured with fine wire. The network is then covered with another equal layer of cement, completing the thickness of the arch, the wrought wire network being thus embedded in the cement as a core. The spandrils are filled in with concrete in the proportion of 1 to 8. The thickness of the wire and the cement arch varies with the span and weight to be carried. In practice the wires are laid on the centering and the cement poured over it, the wires being afterwards lifted to the centre of the thickness of the arch. Slabs or landings are constructed in a similar manner.

FIG. 2.



A very valuable quality of the Monier construction is that it will not suddenly break, crash, or collapse as in ordinary construction,

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* Reprinted by the kind permission of the R. I. B. A.

but it gradually buckles or sags, retaining the weights above (Fig. 2). It is stated that the chief of the Berlin Fire Brigade has issued an official order that firemen are to enter buildings constructed on the Monier system, as there is no risk of floors and ceilings cracking and falling by reason of either heat or water.

It is reported that at a great distillery fire which took place at Wandsbeck, near Hamburg, on the 21st December, 1889, the roof and upper story of the distillery burnt entirely down to the Monier floor. As great quantities of spirits were stored below, any crack in the Monier floor (and ceiling) would have spread the flames throughout the whole building, but accident and loss were prevented by the absolute security of the Monier floor and ceiling. In this case the floor was only $1\frac{3}{4}$ inch thickness; which not only resisted all inroads of the fire and weight of falling timbers, &c., but also the great volume of water which was thrown on it, and which, it must be remembered, came on a red hot surface. There was no crack visible. Another important fact is, that the Monier ceiling protected the iron girders in a most effective manner.

At another great factory fire, at Offenbach, May 4th, 1891, the fire spread with great rapidity throughout the rooms of the upper story. The heat was most intense, for several parts of the machinery, which were made of brass or cast iron, melted, which would indicate a heat of from 800° to 1000°. Between the top and ground floors a free bearing Monier floor, 2 inches thick, had been constructed, which withstood the great heat of the fire. Although many of the iron girders warped considerably, through expansion, their capacity of bearing strength was not greatly impaired, and the lower floors were intact. After a careful inspection by a number of experts, it proved that the Monier ceiling was of the greatest value in resisting the fire; for only a few hours afterwards the firemen were able to walk on the floors with perfect safety, which in ordinary vaulted constructions would have been impossible, owing to the danger of their giving way. The heavy pieces of machinery, &c., had not damaged the Monier floor in the least, but a large tank, weighing over 30 cwt., which fell on the Monier floor from a height of 10 feet made a hole.

Some extensive trials were made in November 1890 in the building yard of the Royal Hungarian Government at Budapest, in the presence of the royal officials. Two experiments were made with two arches of the same shape, 8 feet 9 inches wide, $10\frac{7}{16}$ inches high, and $\frac{3}{16}$ inch thickness; one arch was constructed of the best concrete, and the other on the Monier system. The concrete arch fell in with a tremendous crash under a one-sided weight of 4 tons 14 cwt. 54 lbs., that is at the rate of 17 cwt. 91 lbs. per square metre of $39\frac{1}{2}$ inches, whereas the Monier arch bore a five times heavier weight than the concrete arch, i. e. 24 tons 7 cwt. 16 lbs., or 9 tons 3 cwt. 91 lbs. per square metre (39½ inches), and supported this enormous weight. The carrying weight was therefore five times greater than that of the other arch.

Experiments were also made with a Beton (concrete) plate and a Monier plate, both being 59¼ inches long, 43½ inches wide, and ¼ inch thick: the former broke under a weight of 13 cwt., the latter under a weight of 4 tons 3 cwt. 18 lbs., or twelve times the weight at which the former collapsed.

A strong Monier plate 75 inches long, 76 inches wide, and 6¼ inches thick, carried 21 tons 12 cwt. 16 lbs. without breaking.

On the 17th May, 1890, loading tests were carried out by high officials and experts on a bridge in Matzleindorf, Austria. Span of bridge 30 feet, width 12 feet, thickness of Monier arch in centre 6 inches. The arch was subjected to a severe test—first with rolling stock and afterwards with dead weight, the latter up to 196 tons. The weight was not evenly distributed over the whole arch, but was placed on one-half of it. The brickwork supported by the arch cracked owing to the skewbacks giving way on account of the thrust caused by the heavy weight of the test. The only crack in the Monier arch was at the skewback, owing to the abutment not being strong enough to resist the thrust.

A special report has recently been made by Mr. P. Stuart, managing director of the Granolithic Paving Company (London), in which the following details, among others, are quoted:—

In the case of a factory building in Berlin, the "floors are in five stories; the span between iron joists 12 feet centre to centre; thickness 2 inches; haunches partially filled up. Such a work in England would have at least 5 inches of thickness at crown of arch, and be constructed of concrete or brick, by arches only half the span in size, whilst the cost would be at least 3*s.* per yard more than that of the Monier system, and probably five times its weight, and give no better results."

In a brewery building "three large Monier cross domes have been constructed of a height of 21 feet and diameter 24 feet, with a thickness of only 1½ inch. They are perfect in every way, and thoroughly fire-proof. Such domes constructed in England under existing principles would cost three times the cost of same in Monier."

In a large three-storied railway warehouse the spans "were 19 feet with a thickness of 3 inches. During more than three years the usual traffic of such a warehouse has been carried on, and the floors are as perfect as when constructed."

The domes of the Conservatoire at Dresden have been constructed in "Monier," they are 57 feet in diameter and 32 feet high, filled in between the ribs with glass. Mr. Stuart remarks, "I know of nothing more surprising than this construction."

A bridge at Wildegg "is constructed in Monier, with a span of 130 feet and a thickness of 6 inches at the crown, without iron girders. This bridge was built in 1890 and is at the present day in excellent condition."

A foot bridge at Bremen has a span of 130 feet, only 8 inches thick, without a single iron girder.

Sewage and Water Pipes.

Sewage and water pipes on the Monier or Zisseler system are manufactured on a very large scale, so as to bear the same strains as iron pipes, and, it is stated at one-third the cost and practically unbreakable. In Germany pipes are made of concrete by machinery with an iron network core on the same principle as shown in Fig. 1, with diameters from 6 inches up to 9 feet, the thicknesses varying from 1 inch to 2 inches according to the sizes of the pipes. The thickness of the iron wire network embedded in the cement varies also according to the size of the pipe. When laid with either a collar or an ordinary pivot and socket joint they are said to be perfectly water-tight. In ordinary soil they can be laid without a concrete foundation, similarly to iron pipes. In the last official test for a sewerage contract for the Strasburg municipality, the pipes, 9 feet in diameter, were tested with water pressure and found satisfactory.

Monier pipes will probably not be able to compete in price with ordinary glazed earthenware of a less diameter than 12 inches, but where strength is required Monier pipes would doubtless be preferable even at a higher cost. From 12 inches upwards prices are quoted at less than earthenware, and very much less than iron pipes.

Several towns in Germany have been already sewered with Zisseler pipes, and testimonials are given by the municipal engineers in each case testifying to their satisfactory results. It has been considered by competent authorities that for water pipes the Monier are superior to iron, in consequence of the smoothness of the internal bore, which saves the friction inseparable from the inequalities of cast or wrought iron mains. The pipes can be made almost as smooth inside as if made of glass.

Fortification.

The Monier system is also capable of being employed for fortifications. Trials made by the German and Austrian Governments have proved that Monier arches being of elastic construction, whilst not so thick and heavy as brick or stone arches, are far superior and better able to stand shocks from balls and shells, and capable of sustaining greater loads. Monier arches may be deformed by heavy shot, but do not collapse like brick or stone work.

In the tests the Monier showed to the greatest advantage when a layer of sand was placed over it, as the shock-distributing influences of the sand are taken up by the Monier arch, which in a rigid stone or brick arch is impossible.

For this reason brick or granite passages, or casemates must collapse when bombarded, whilst a Monier passage will remain passable to the last.

The tests have proved so satisfactory that both the German and Austrian Governments are, it is stated, adopting the Monier system for fortifications and in barracks.

The foregoing is intended as only a general description to call attention to the wonderful results on the Continent of this new system capable of such wide application. Its conception in a modified form is not altogether new. There have been proposals to introduce a wire-wove core in various forms, but there has not hitherto been any practical application of the principle to actual construction in this country. The results are new and interesting, and well worthy the attention of British engineers and architects. The evidence is believed to be reliable, and some of the facts above quoted have come under the personal observation of the author.

Returns, or Books of Statistics, on the following subjects lie at the Offices of the Association, 11, Victoria Street, Westminster, S.W., and are open to the inspection of members.

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1. Particulars of Sewage Purification and Disposal. Returns from 41 towns. Compiled by H. Richardson, A. M. Inst. C.E., Town Surveyor, Oldbury. 1890.

2. Statistics relating to Water Supply for Domestic, Trade, Sanitary, Street-watering, and Public Purposes. Information from 111 towns. Compiled by J. T. Eayrs, A. M. Inst. C.E., Borough Surveyor, West Bromwich. 1890.

3. Comparison of Cost and Life of Granite and Gritstone Pavement. Information received from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Borough Surveyor, Sheffield. 1890.

4. The Collection of House Refuse. Returns from 89 towns. Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

5. The Disposal of House Refuse, &c. Returns from 39 towns. Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

6. Particulars respecting Tar Macadam. Returns from 72 towns. Compiled by Joseph Hall, A. M. Inst. C.E., Borough Surveyor, Cheltenham. 1891.

7. Information on the Working of Shone's Hydro-Pneumatic System. Returns from 20 towns. Compiled by E. Buckham, M. Inst. C.E., Borough Surveyor, Ipswich. 1891.

8. Tabulated Statement as to Road Watering. Returns from 65 towns. Compiled by W. Dawson, A. M. Inst. C.E., Local Board, Leyton. 1891.

9. Information with reference to Street Tramways. Returns from 48 towns. Compiled by J. E. Swindlehurst, A. M. Inst. C.E., Borough Surveyor, Burton-upon-Trent. 1891.

10. Information with reference to Electric Lighting. Returns from 88 towns and 10 London Vestries. Compiled by J. W. Cockrill, A. M. Inst. C.E., Borough Surveyor, Great Yarmouth. 1891.

11. Particulars of Gas Undertakings in the hands of Local Authorities. Returns from 38 districts. Compiled by Percival

Ross, A. M. Inst. C.E., Engineer to the Local Board, North Bierley. 1891.

12. Information obtained relative to the Construction of Works of Private Street Improvements. Returns from 49 towns. Compiled by W. J. Newton, A. M. Inst. C.E., Borough Surveyor, Accrington. 1892.

13. Information respecting Sewage Disposal. Returns from 53 towns. Compiled by J. H. Cox, M. Inst. C.E., Borough Surveyor, Bradford. 1892.

14. The Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions for 1891. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M. B. 1891.

Reports.

Annual Report, City Surveyor, Sydney. 1889.
Ditto ditto 1890.
Ditto ditto 1891.

Means of Regulating Vehicular Traffic. City Surveyor, Sydney. 1891.

Specification, Wood Paving and Cube Sett Paving. City Surveyor, Sydney.

Report upon the Disposal of Refuse, &c., in Cities of Melbourne and Adelaide. City Surveyor, Sydney. 1891.

Yearly Report. City Surveyor, Montreal. 1890.

Report on Cable Tramways. Borough Surveyor, Bradford. 1890.

Annual Report. Surveyor Local Board, Willesden. 1890–91.

Annual Report. Surveyor to the Vestry of Fulham. 1890–91.

Annual Report. Borough Surveyor, Stockport, to the Highways and Sewers Committee. 1890–91.

Report on the Collection and Disposal of House Refuse. Surveyor to Local Board, Wimbledon. 1891.

Annual Report. City Surveyor, Montreal. 1891.

Annual Report of the Metropolitan Board of Water Supply and Sewerage. Sydney. 1891.

Annual Report of Borough Surveyor of Stockport. 1891–92.

Papers on Sewer Ventilation, with Report of Mr. Gilbert Redgrave. 1891.

Report on Lighting the City of Liverpool by Electricity. City Engineer, Liverpool. 1892.

VOLUNTARY EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers have undertaken the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

Two Examinations are held in each year; one in April, in London, and one in October, in some provincial town to be fixed on by the Council and advertised in the *Builder* six months beforehand.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects:—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Public Health Acts, and Rivers Pollution Acts.

Examples of the class of questions proposed to be asked under these heads are appended hereto.

Candidates are allowed two hours to answer the questions under each of the four heads, and are not necessarily required to answer all the questions set in each paper, though not less than four must be taken: marks are given for all questions properly answered. The *vivâ voce* examination is held after the written papers have all been sent in, and is directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations extend over one or two days, as circumstances may require, and in the latter case the arrangements will be, as far as possible, as follows:—

First day ..	10	to 12 ..	Engineering.
„ ..	2	„ 4 ..	Building Construction.
„ ..	5	„ 7 ..	Sanitary Science.
Second day ..	9.30	„ 11.30	Public Health Law.
„ ..	1	„ 4 ..	*Vivâ voce* Examination.

The total number of marks required to constitute a pass is 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he will be entitled to present himself again at the next, or any subsequent Examination, on payment of one-half of the above fee.

No further charge will be made to the candidate than the fees above mentioned.

Candidates that do not present themselves for the Examination forfeit the entrance fee.

Successful candidates are entitled to receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thomas Cole, Secretary to the Association, 11, Victoria Street, S.W.

SUBJECTS OF EXAMINATION.

I.—ENGINEERING AS APPLIED TO MUNICIPAL WORK:

- A. Land Surveying and Levelling.
- B. Hydraulics.
- C. Drainage and Sewerage.
- D. Water Supply.
- E. Road Making.

II.—BUILDING CONSTRUCTION: STRENGTH OF MATERIALS:

- A. Materials.
- B. The Construction of Public and Private Buildings.
- C. Building Bye-laws.

III.—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS:

- A. Ventilation.
- B. Sewage Disposal.
- C. House Drainage.

IV.—PUBLIC HEALTH ACTS.
RIVERS POLLUTION ACTS.

TWELFTH EXAMINATION.

The Twelfth Examination of Candidates was held at the Town Hall, Manchester, on the 2nd and 3rd October, 1891, at which the following Examination Papers were set to the Candidates.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner:—E. Pritchard, M. Inst. C.E.

1. What constitutes an ill-conditioned triangle? Give sketch. Show what lines you would use in making a survey of a road with the chain only; all the lines to be within the roadway. (See sketch.) Give the first page of the field book of such survey, embodying all the signs and measurements generally used. How would you show a "quick" fence, a post-and-rail fence, a wall, fence with bank, footpath, gate, sunk road, raised road, church, and covered passage?
2. How would you test the adjustment of a level in the field? How would you adjust a "dumpy" level so as to bring the line of collimation parallel to the axis of the instrument?
3. How would you proceed to take levels for contouring?
4. What is the height of a column of water balanced by an atmosphere of 30 inches of mercury, and what is its equivalent in lbs. per square inch? Who discovered this law? What is the formula giving the velocity due to gravity?
5. At what temperature Fahrenheit and Centigrade does water attain its greatest bulk? Explain the bursting of lead pipes in frosty weather and how it may be prevented.
6. What are considered self-cleansing velocities in sewers of large and small diameters? What formula is in general use for the velocity in sewers, and to whom is it ascribed? When does a circular sewer discharge its greatest volume?
7. Give a figured sketch of an egg-shaped sewer, 3 feet 9 inches by 2 feet 6 inches, in tunnel, through loose gravel, showing timbering and the names of the various pieces. What precaution should be adopted to keep the heading dry?
8. Give sketch of a coffer dam to be used in constructing a cast-iron inverted syphon under a river flowing 10 feet deep, with a gravel bed. Give sketches of the shoes you would use for sheet piles and guide piles, and a general sketch section of the syphon and manholes at each end.
9. Describe the "International" process of sewage purification, and explain the action of the filtering material upon the sewage.
10. In calculating the size of a gravitating delivery main for water, what would you allow as its maximum discharging capacity, with reference to present population—state how you arrive at your result, assuming your own rate per head and population. In the case of a pumping scheme, how would you determine the size of the rising main?

11. Give a sketch plan and section showing the construction of a service reservoir to hold 1,000,000 gallons of filtered water, with inlet, outlet, overflow, and wash-out.
12. Describe the manner in which you would repair a macadamised road, the size and quality of stone you would use, the best method of breaking the stone, with reasons, the weight of steam roller you prefer, and why.

SUBJECT :—BUILDING CONSTRUCTION, &c.

Examiner :—James Lemon, M. Inst. C.E.

1. Draw a section of the front wall of a warehouse, five stories in height.
2. Draw a figured cross section of a fireproof floor to carry 2½ cwt. per foot super.
3. Write brief specification for concrete foundation and brickwork for question No. 1.
4. The basement of a building being subject to flooding from the rising of the water level in the ground, what would you advise to render it watertight.
5. Draw sketch plan and section, with figured dimensions of timbers, for floor to room on first floor 24 feet by 18 feet.
6. Draw sketch section of a kingpost roof covered with slates, with figured dimensions of timbers for 26 feet span, trusses 10 feet apart.
7. Draw sketch section of a wrought-iron truss to roof 40 feet span, with figured dimensions of all parts thereof; mark by letters C and T where in compression and tension.
8. Draw cross section of girders and front wall over shop front three stories in height, 10 feet, 9 feet, and 9 feet respectively, frontage 20 feet, depth of building 30 feet.
9. Write specification in detail for 2-inch double hung sashes and frames.
10. Write specification for plasterer's work.

SUBJECT :—SANITARY SCIENCE.

Examiner :—A. M. Fowler, M. Inst. C.E.

1. State the minimum velocity required in the flow of sewage to keep a sewer free from deposit.
2. State a formula to ascertain the velocity.
3. Show by sketch how to set out, on the ground, a plan of a main sewer, i. e. in an irregular formed street, and a sketch to secure the correct carrying out of the levels.
4. State how small sewers and house drains should be constructed in wet ground to secure watertight joints. The best joint for adoption.
5. State a ready method for ascertaining the presence of chlorine in drinking water, i. e. when contaminated by sewage.

6. From what sources can water be obtained for domestic use? Classify them in respective order of quality.
7. In selecting a site for a first-class dwelling, what would be the principal conditions you would endeavour to secure?
8. State the best means for passing off vitiated air in a water-closet room.
    (*a*) The best position for such room.
9. What is the best position for the water apparatus in a first-class dwelling, i. e.
    (*a*) The position of the boiler.
    (*b*) Hot and cold water cisterns.
    (*c*) Bath room.
    (*d*) The precautions necessary to prevent damage by frost. Give sketch of living rooms say on ground floor, with relative position of water apparatus.
10. How would you ventilate the staircase and main body of a first-class dwelling?

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner:—Chas. Jones, M. Inst. C.E.

1. Give a brief epitome of the principal objects of
    (*a*) The Public Act.
    (*b*) The Rivers Pollution Act.
2. Name some of the principal sections and their special application.
3. State the provision made in a late Session of Parliament in modification of the 156th Section.
4. Give the names and objects of (say four) Acts of Parliament passed during the Sessions 1887–1891 (inclusive), having to do with the amendment of the Public Health Act, or for incorporation with same.
5. Detail the section having special reference to "Nuisances," and describe proceedings to be taken.
6. Describe generally the provisions of the Public Health Act bearing upon "Contracts" taken by a Local Board.
7. Under what Act is a Local Board authorised to enter upon land for purposes of the Public Health Act?
8. Certain provisions (4) of the Towns Improvement Clauses Act are included in the Public Health Act. Name them.

Five candidates presented themselves for examination, of whom the following four satisfied the examiners, and were granted their certificates:—

Dolamore, F. P. (Bournemouth).
Ingham, W. (St. Helens).
Naylor, W. (Wolverhampton).
Roberts, F. (Birkenhead).

THIRTEENTH EXAMINATION.

The Thirteenth Examination was held at the Institution of Civil Engineers, Westminster, S.W., on the 1st and 2nd April, 1892, when the following Examination Papers were set to the candidates.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner:—Clement Dunscombe, M.A., M. Inst. C.E.

1. Explain the principle of the Vernier Scale, and express in general terms the mode of reading with it, and construct Vernier Scales to read to 20 seconds and $\frac{1}{100}$ths of an inch respectively.
2. In surveying with the Theodolite, and also without an angular instrument, describe in each case how you would ascertain, with approximate accuracy, the direction of the Meridian.
3. Lay down the main lines and tie lines you would propose in making a chain survey of the district shown in Diagram B, the survey having reference more particularly to a correct delineation of the boundaries of the district, and the calculation of its area.
4. Describe how you would make an accurate Traverse Survey with the Theodolite, of the Main Road shown on Diagram C.
5. From a point on Bromley Hill, the top of the tower of the Crystal Palace was found to coincide with the horizontal wire of a levelling telescope when adjusted for observation. The distance of the instrument from the Palace was three miles. Find the true difference in level between these two points, and explain fully the corrections which you would make and the reasons for them; and how are these corrections obviated in practical levelling operations?
6. A reservoir when full has a depth of 49 feet over the centre of the discharging sluice, which has an area of 2 feet by 2 feet when fully opened. Calculate the discharge from it at that depth, and also when the water has lowered to heads of 36 feet, 25 feet, and 16 feet respectively, the co-efficient of discharge being taken at 0·62 in each case.
7. Calculate the discharge in cubic feet per minute, and the velocity, in feet per second, in the case of a 12-inch pipe running full, and laid at a gradient of 1 in 324.
8. What will be the diameter of a pipe to deliver 2,000,000 gallons in 24 hours, at a mean velocity of 2½ feet per second? also calculate the mean I.H.P. required to pump this quantity through such a main, the total lift, including friction, being 60 feet, and assuming an efficiency of 0·8 for the engine employed.
9. The accompanying diagram marked A represents a section of a town requiring to be sewered into an intercepting sewer already provided. Lay down upon the plan the sewers you would recommend, their size, gradients, and show their direction (by arrows). Also mark the position of the manholes, inspection shafts, &c., and make freehand sketches of these.

10. State briefly the most important points which require careful examination, when considering a water supply from a drainage area.
11. Specify for the following materials for first-class work, quality, dimensions, &c.:—Broken stone for road repairs, flags, dressed granite edge kerb, flat kerb, granite or syenite set 3 inches by 5 inches deep, creosoted wood paving blocks; also for a cement concrete foundation for set pavement subject to heavy traffic. Make an estimate for the maintenance of a macadamised road, including the cost of scavenging and watering, with a traffic of 30,000 tons per yard width of street, assuming your own prices for materials and labour. Ditto, ditto, for a paved street with 80,000 tons traffic.
12. Calculate the tension on the bottom flange of each of two lattice girders 16 feet in depth (the thickness of flange need not be considered) and 160 feet span, with a distributed load of 320 tons.

SUBJECT:—BUILDING CONSTRUCTION, &c.

Examiner:—James Lemon, M. Inst. C.E., F.R.I.B.A.

1. Write a specification for Portland cement concrete, and brickwork.
2. Draw a vertical section of a wall four stories high in accordance with the Model Bye-Laws.
3. Draw a plan of a double-framed floor to a room 30 feet by 20 feet, and figure sizes of timbers.
4. Draw a framed and trussed partition 20 feet long by 12 feet high, with a doorway in the centre, 7 feet by 3 feet, and figure sizes of timber.
5. Make a figured sketch of a queen-post roof, for 40 feet span, trusses to be 10 feet apart, and show construction of parapet wall at one end..
6. Make a figured sketch of an iron trussed roof, with wood purlins and 1¼ inch boarding thereon for 30 feet span, trusses to be 10 feet apart.
7. Draw an elevation and cross section of a wrought-iron riveted girder for a 24-feet span, to carry a safe distributed load of 19 tons.
8. Draw plan and cross section of a public swimming bath, 75 feet by 30 feet internal dimensions.
9. Write specification for the wood flooring and plastering to walls of a ward in an Infectious Hospital.
10. Write a specification for slating and tiling the roofs of ordinary buildings, giving full details of lap, mode of fixing tiles and slates, and covering to ridge and hips.
11. Write specification for plumbers' work to a bath, lavatory, and w.c., to house of the value of £1000.
12. Make sketch elevation of a party wall, three stories high, showing fire-places and flues.

SUBJECT :—SANITARY SCIENCE.

Examiner :—C. Jones, M. Inst. C.E.

Give a brief reply to following question (not to exceed 12 lines) :—

1. What do we understand by "Sanitary Science"?
2. Describe the essentials (Sanitary) required in the general arrangement of a Dwelling-house, 30 feet frontage, three stories in height (exclusive of cellars) :—
   - (*a*) As to Site and Foundation.
   - (*b*) As to internal arrangement of Rooms and Offices.
   - (*c*) As to ventilation of Reception and Bedrooms.
3. Describe (in your opinion) the best form of w.c. with water supply to same :—
   - (*a*) To above house.
   - (*b*) To six-room Cottage.
4. Give the amount of pure air required for Man—and a Candle.
5. Give the principal sources of contamination of Drinking Water :—
   - (*a*) In Rivers and Wells.
   - (*b*) In House Cisterns.
6. Detail the principal causes leading to the impurity of the Air :—
   - (*a*) Externally.
   - (*b*) In Dwelling-houses.
7. In the drainage of a Town, describe the several advantages of—
   - (*a*) The Separate System.
   - (*b*) The Combined System.
8. Describe the best mode of Ventilation as applicable to Town Drainage.

SUBJECT :—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner :—Joseph Lobley, M. Inst. C.E.

The words "the Act" mean the Public Health Act, 1875.

1. Give the Definitions under the Act of "sewer," "drain," "street," "owner."
2. Describe the meaning under the Act of "Private Improvement Expenses," "Cost of Private Improvements," "Private Improvement Rate," and give the different modes of recovering the amounts; from whom and within what time.
3. Twenty houses require draining into the public sewer. Describe generally the powers of a Local Authority. (*a*) When each house is separately drained to the public sewer, and (*b*) when it would be better and cheaper to divide the houses into groups of 9, 7 and 4, with one sewer to each group. After the work is done, give the method of apportioning the cost, stating how much must be paid by the owners and how much paid by the Local Authority.

4. The cost of making up a private street (called on plan New Street) amounts to 100*l.* from North Street to King Street, 160*l.* from King Street to South Street, and 28*l.* where King Street crosses New Street. The frontages in feet are given on the plan; make out an apportionment according to Section 150 of the Act.
5. The majority of the owners of a private street in which the sewer has been laid were willing that a limited amount of work should be done, namely, curbing, channelling, metalling carriageway and gravelling footpaths. The Local Authority accordingly served the notices and carried out the work. Describe fully what further steps must be taken before the street can be declared a highway repairable by the inhabitants at large.
6. Describe some of the principal provisions of the Public Health Acts Amendment Act, 1890, Part 3, as affecting a local Surveyor's work, and particularly how question 5 is affected by it.
7. State the provisions of the Act on the following points:—(*c*) Dangerous buildings; (*d*) dangerous places; (*e*) improving the line of existing public streets; (*f*) under what circumstances have the Authority compulsory powers to take land to improve public streets? (*g*) State the course to be taken to acquire such powers.
8. State the requirements of the Act with reference to contracts. (*h*) What amount can a Committee be delegated to accept? (*j*) At what amount must the agreement be in writing? (*k*) Under what circumstances must advertisements for tenders be made public?
9. State shortly the necessary proceedings by a Local Authority against a manufacturer who, in contravention to the Rivers Pollution Act, pours polluted liquid into a watercourse, such polluted water not being admissible into the sewers of the Local Authority.

Eighteen Candidates presented themselves for Examination, of whom the following eleven satisfied the Examiners and were granted their certificates:—

Anderson, J. R. (Norwood).
Andrews, C. P. (Highgate).
Ball, J. B. (King's Cross).
Bradshaw, J. B. (Gateshead).
Cross, F. W. (Walsall)
Fitton, G. (Reading).
Hills, H. J. (Clapham).
Lloyd, C. (Chatham).
Shackleton, C. W. (Coseley).
Veit, L. J. (Ipswich).
Yates, F. S. (York).

BOARD OF EXAMINERS.

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Borough Engineer, West Ham (Past President).

H. P. Boulnois, M. Inst. C.E., City Engineer, Liverpool (Past President).

W. Santo Crimp, M. Inst. C.E., F.G.S., M.S.I., District Engineer, London County Council.

E. B. Ellice-Clark, M. Inst. C.E., late County Surveyor, West Sussex (Past President).

A. M. Fowler, M. Inst. C.E., late Borough Surveyor, Stockport.

T. Hewson, M. Inst. C.E., Borough Engineer, Leeds (Vice-President).

C. Jones, M. Inst. C.E., Surveyor to the Local Board, Ealing, W. (Past President).

W. G. Laws, M. Inst. C.E., City Engineer, Newcastle-on-Tyne (Past President).

James Lemon, M. Inst. C.E., F.R.I.B.A., Consulting Engineer, Southampton (Past President).

Jos. Lobley, M. Inst. C.E., Borough Engineer, Hanley (Past President).

T. De C. Meade, M. Inst. C.E., Surveyor to the Local Board, Hornsey (Past President).

E. Pritchard, M. Inst. C.E., 37, Waterloo Street, Birmingham (Past President).

CANDIDATES WHO HAVE PASSED THE EXAMINATION.

Date of Certificate.	
May 7, 1887	Adcock, C. (Liverpool).
May 2, 1891	Allen, S. (Radcliffe).
Apr. 23, 1892	Anderson, J. R. (Norwood).
Apr. 23, 1892	Andrews, C. P. (Highgate).
May 1, 1886	Angell, J. A. (Leytonstone).
May 1, 1886	Ashmead, H. (Clifton).
Oct. 19, 1889	Aspinall, M. (Cardiff).
May 2, 1891	Ball, B. (Middleton).
Oct. 18, 1890	Ball, C. F. (Croydon).
Oct. 16, 1886	Ball, G. (Scarborough).
Apr. 23, 1892	Ball, J. B. (King's Cross).
May 12, 1888	Barnes, S. W. J. (Ealing).
May 12, 1888	Bayley, G. H. (Salford).
Oct. 16, 1886	Beard, E. T. (Lincoln).
May 12, 1888	Beynon, J. C. S. (Exeter).
Apr. 13, 1889	Blizard, J. H. (Southampton).
Apr. 13, 1889	Bradley, J. W. (Burnley).
Apr. 23, 1892	Bradshaw, J. B. (Gateshead).
Nov. 17, 1888	Brown, R. R. (Bridlington Quay).
Oct. 16, 1886	Brownridge, C. (Leeds).
May 12, 1888	Bryans, J. G. (Sunderland).
Nov. 17, 1888	Bryning, W. G. (Liverpool).
Oct. 19, 1889	Bucknall, Hy. (Stratford-on-Avon).
Apr. 13, 1889	Carter, G. F. (Leeds).
May 3, 1890	Catchpole, J. H. (Hendon).
May 1, 1886	Coales, H. G. (King's Lynn).
Oct. 22, 1887	Cook, J. (Bury).
May 12, 1888	Cooper, C. H. (Wimbledon).
May 7, 1887	Cooper, F. E. (Liverpool).
May 2, 1891	Cooper, W. (Cheetham).
Apr. 23, 1892	Cross, F. W. (Walsall).

Date of Certificate.	
May 12, 1888	Crow, A. (Stratford, E.).
Oct. 16, 1886	Crowther, J. A. (Leeds).
May 7, 1887	Dearden, Hy. (Leeds).
May 2, 1891	Dixon, J. R. (Carlisle).
Apr. 13, 1889	Dixon, W. B. (Wolverhampton).
Oct. 17, 1891	Dolamore, F. P. (Bournemouth).
Oct. 18, 1890	Dyack, W. (Aberdeen).
Oct. 18, 1890	Edge, F. J. (Barrow-in-Furness).
May 1, 1886	Fenton, W. C. (Sheffield).
Nov. 17, 1888	Field, W. C. (Eastbourne).
May 12, 1888	Finch, A. R. (Finchley).
Apr. 23, 1892	Fitton, G. (Reading).
May 7, 1887	Franks, T. W. (West Bromwich).
Oct. 19, 1889	Gaffney, F. S. B. (Athleague).
May 3, 1890	Gibbs, L. (Walsall).
May 12, 1888	Glass, S. N. (Hackney).
May 12, 1888	Gloyne, R. M. (Manchester).
May 2, 1891	Graves, M. D. (York).
May 1, 1886	Greatorex, A. D. (Toxteth Park).
Oct. 18, 1890	Hall, W. (Ealing, W.).
Nov. 17, 1888	Hawkins, I. T. (Chichester).
Apr. 23, 1892	Hills, H. J. (Clapham).
May 12, 1888	Houghton, J. (King's Heath).
May 2, 1891	Hurd, H. (Bath).
Oct. 17, 1891	Ingham, W. (St. Helen's).
Oct. 16, 1886	Jameson, M. W. (Leeds).
Apr. 23, 1892	Lloyd, C. (Chatham).
May 12, 1888	Lynam, G. T. (Barnsley).
Oct. 16, 1886	Mallinson, T. (Selby).
Oct. 18, 1890	Manley, J. (Liskeard).
Oct. 22, 1887	Mellor, T. E. W. (Stockton).
Oct. 22, 1887	Metcalf, J. W. (York).
May 3, 1890	Miller, J. E. (Durham).
Nov. 17, 1888	Millington, J. S. (Wavertree).
May 12, 1888	Milnes, G. P. (Wakefield).
Oct. 17, 1891	Naylor, W. (Wolverhampton).
Apr. 13, 1889	Nettleton, H. (Leeds).
May 7, 1887	Nichols, A. E. (Leeds).
May 7, 1887	Nickols, F. J. (Leeds).
Oct. 19, 1889	Noakes, H. S. (Tunbridge Wells).

Date of Certificate.	
May 1, 1886	Osborne, F. (Dover).
Oct. 22, 1887	Parker, W. (Hereford).
Oct. 16, 1886	Pickering, J. S. (West Bromwich).
Oct. 19, 1889	Preston, T. (Bradford).
May 12, 1888	Pritchard, T. (Richmond).
May 7, 1887	Rich, E. W. (Hounslow).
Oct. 17, 1891	Roberts, F. (Birkenhead).
May 2, 1891	Saise, A. J. (Stapleton).
May 1, 1886	Saunders, E. E. (Walthamstow).
May 7, 1887	Saunders, J. (Newark).
Oct. 22, 1887	Saville, R. W. S. (Accrington).
Apr. 23, 1892	Shackleton, C. W. (Coseley).
Oct. 16, 1886	Silcock, E. J. (Leeds).
Apr. 13, 1889	Stringfellow, W. (Cheltenham).
Oct. 18, 1890	Sumner, F. (Kilburn).
Oct. 16, 1886	Sykes, E. (Reddish).
Apr. 13, 1889	Taylor, W. J. (Southampton).
Oct. 16, 1886	Thomas, R. J. (Carnarvon).
Oct. 19, 1889	Thomas, T. (Neath).
Apr. 13, 1889	Tomes, G. B. (Eastbourne).
Oct. 16, 1886	Turner, V. H. (Leeds).
Apr. 23, 1892	Veit, L. J. (Ipswich).
May 7, 1887	Verschoyle, B. (Liverpool).
Oct. 22, 1887	Ward, F. D. (Manchester).
May 12, 1888	Wilson, C. L. W. (Bacup).
Nov. 17, 1888	Wilson, J. B. (Cockermouth).
May 1, 1886	Witts, J. W. (Skelton).
May 3, 1890	Wood, J. W. (Rochdale).
May 2, 1891	Yarwood, Hy. (Rochdale).
Apr. 23, 1892	Yates, F. S. (York).
Oct. 16, 1886	Young, W. (Pendleton).

Memoirs of Deceased Members.

The Council, having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

It is with much regret that the Council have to chronicle the death of Mr. John Thornhill Harrison, Honorary Member. The following is extracted, by kind permission, from the 'Minutes of the Proceedings Inst. C.E.,' vol. cix. p. 405 :—

John Thornhill Harrison, son of the late Mr. William Harrison, was born at Thornhill, near Sunderland, on the 4th February, 1815. He was educated at the Grange School, Sunderland, and at Edinburgh University, and was then articled to his elder brother, the late Mr. Thomas Elliot Harrison, Past President of the Institution. His first employment was on the London and Birmingham Railway, after which he was in his brother's office at South Shields, and subsequently on the Stanhope and Tyne Railway, now forming part of the North-Eastern Company's system.

On the expiration of his pupilage, in 1838, Mr. Harrison was engaged, under the late Mr. I. K. Brunel, on the construction of the Great Western and South Devon Railways. In 1851 he retired temporarily from the profession, and devoted his attention to agricultural pursuits, farming a holding of about 500 acres near Stroud in Gloucestershire. He became a Member of the Council of the Royal Agricultural College at Cirencester, and wrote a number of articles on various subjects of interest to the agricultural world, which appeared from time to time in the 'Journal of the Royal Agricultural Society.'

In 1865 the attention of the Home Office, which was then entrusted with the administration of all matters affecting sanitation, was drawn to the increasing pollution of rivers and streams by the discharge into them of the refuse of towns and manufactories. A Royal Commission on the Pollution of Rivers was constituted, and, as it was thought that Mr. Harrison's double experience as a practical farmer and engineer would be of special value, he was appointed a member, his colleagues being Mr. (now Sir Robert) Rawlinson and the late Professor Way. The Commission existed for two years, and made exhaustive reports on the Thames, the Lea, and the rivers of the West Riding of Yorkshire. These may be found in the Library of the Institution.

In 1871 Mr. Harrison was offered, by the then Home Secretary, Mr. Bruce (now Lord Aberdare), an Engineering Inspectorship in the Local Government Act Office, the work of which was transferred in the following year to the Local Government Board. From that time until his death, twenty years afterwards, he continued to discharge his duties as one of the engineering inspectors of that Board. In that capacity he was constantly engaged throughout the country in holding inquiries with reference to applications from Local Authorities for permission to borrow money for the carrying out of municipal undertakings of all kinds. Some of the most important with which Mr. Harrison had to deal were the schemes promoted from time to time by the Corporation of Birmingham; and there is scarcely a large town in the kingdom in which he did not, at some time or other during his connection with the Local Government Board, conduct one or more of these inquiries. In their conduct he was kind and considerate, rigorously exact in enforcing the provisions of the Acts of Parliament he had to administer, but ever careful to promote to the utmost the interests of the various districts concerned.

Mr. Harrison's death, which took place on the 4th of November, 1891, may be attributed to a gradual breaking-up of the physical powers, rather than to any specific disease. He was well known in Ealing, where he had resided for nearly twenty years, and had taken an active interest in all movements tending to promote the welfare of the town. He was an ardent educationalist, devotedly attached to the voluntary system, and, as a member of the Executive Committee of the Ealing Educational Association, displayed a warm concern in all questions connected with the elementary instruction of the young. He was also an active member of the Committee of the Ealing Cottage Hospital, a Vice-President of the Ealing and District Gardeners' Mutual Improvement Association, and a warm supporter of the local Horticultural Society. Possessed of great kindliness of heart and geniality, his presence was always welcome at the gatherings of the various institutions with which he was associated.

M. Alphand, the celebrated engineer and the chief embellisher of modern Paris, died on the 6th December, 1891. He was seventy-four years old, and had been ailing for some weeks. Charles Adolphe Alphand was born in Grenoble in October 1817. M. Alphand superintended the organisation of three Universal Exhibitions, and was the guiding spirit of the last World's Fair, which he intended at first to establish on the Courbevoie Plain. Afterwards he agreed with his colleagues as to the Champ de Mars site, and threw himself heart and soul into the undertaking. Despite his age, he was to be seen every morning directing the Exhibition works, and he left no stone unturned in order to bring his vast conceptions to a successful issue. For his labours he was rewarded with the Grand Cross of the Legion of Honour—a dignity never conferred before on an engineer. Another honour, which he esteemed highly, was the Membership of the Academy of Fine Arts, to which he succeeded on the death of his old patron and former chief, Baron Haussmann. M. Alphand was elected an Honorary Member of the Association in May 1887.

Mr. JOHN WILLSON was appointed Surveyor to the Ashford Local Board, in April, 1884, from amongst a large number of candidates, and up to the time of his death carried out many important improvements in the town, amongst them being the alterations to the water works, the making up, &c., of several roads, and the supervision of the new sewerage works during their construction; he also introduced cement paving, *in situ*, into the town.

On the 15th day of October, 1891, while inspecting an old drain in New Rents, Ashford, he inhaled a large quantity of sewer gas. He rapidly sickened with typhoid fever, took to his bed on the 21st of October, rapidly became worse, and died on the 5th of November, 1891, aged 43 years, his decease having been caused in the execution of his duty.

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